The Journal
OF THE
Royal United Service Institution.

VOL. VI. 1862. No. XXIV.

LECTURES.

Friday, February 7th, 1862.

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GERMAN CAMPAIGNS OF GUSTAVUS ADOLPHUS.

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THE military glory of Austria and the Roman Catholic confederacy known as the League had reached its highest point in the twelfth year of the Thirty Years' War. The King of Denmark, defeated at Lütter, and driven to his islands by the combined operations of Tilly and Wallenstein, had been forced to sacrifice his political and religious sympathies to the misery of his subjects and the exhaustion of his resources. Mansfeld, a thorough soldier of fortune, had vainly raised three successive armies in defence of the Protestant cause, and had campaigned with them in Bohemia, Westphalia, Saxony, and Silesia, with a celerity of movement that was equalled only by the ease with which he repaired his losses in the field. Antæus-like, he seemed to rise stronger from every overthrow. Pay was unknown in his armies, but its place was fully supplied by an unlimited licence to plunder. It is of course impossible for any army living, as it were, from hand to mouth under conditions such as these, and never dreaming of forming magazines, to secure a base of operations or to conduct a regular campaign. The exhaustion of the resources of the surrounding country of itself creates a necessity for a change of plan, and for the tranference of the locality of hostilities to lands that have hitherto escaped the grasp of the marauder. As a rule, such a desultory system of warfare must eventually succumb to the more elaborate operations of regular troops. It reflects no small glory on Mansfeld's military capacity, that through many years of warfare, and till the defeat of the King of Denmark decided the event of the contest in Northern Germany, he continued to baffle the skill and thwart the plans of the ablest generals of Austria and the League. Even after the intelligence of the crowning disaster of Lütter, when a less hardy spirit would have retired from the field, he formed the idea of carrying his arms into the very heart of

Austria; and, breaking through the dense circle of his opponents, evading the hot pursuit of Wallenstein, and suddenly appearing in Transylvania, he engaged the sympathies of Bethlem Gabor in favour of a broken army and a ruined cause. But the Prince of Transylvania, alarmed at the rapid approach of Wallenstein, concluded a peace as precipitately as he had appealed to arms, and Mansfeld, disbanding his army, retired to Venice, where he soon died of a broken heart. In the same year the deaths of Christian of Brunswick Lüneburg and the Duke of Saxe Weimar deprived the Protestant cause of its last supporters, and left it exposed to the full power of Austria, aided by the military talents of Tilly and Wallenstein, by the active co-operation of the League, and the inexhaustible resources of the Spanish empire.

Few men have left behind them a more terrible reputation than John of Tzerklas, Count of Tilly, a companion of the order of Jesuits, and generalissimo of the army of the League. The Church of Rome, as indeed every other church, has in all times of its existence commanded the service of a body of enthusiasts, prepared, nay anxious, to sacrifice every feeling of humanity to their passionate ardour for the supremacy of their faith. And never had Rome a more devoted son than Tilly. Wine, wealth, and woman's love, the desire of knowledge and the thirst of fame, find responsive chords in almost every breast. But Tilly's heart, dead to every softer mood, insensible to every loftier inspiration, was swayed but by a single influence—his passionate ardour for the victory of his creed. Even his constant success in the field seemed to him less a result of his military ability than an evidence of the favour with which the saints regarded his feeble efforts; and to his mind the sacrifice of a heretic, the destruction of a heretic city, was a deed for which his ecclesiastical superiors might of their grace demand admission for his soul into the mansions of the blest. Great soldiers have sprung from temperaments of such a mould; and it seemed at one time as if few or none of these would be able to contest the crown of pre-eminence with Tilly. Yet, as it often happens with those whose life lies on the verge of two widely different eras, it was his hard fate by the onward course of events to lose in one day the glories of seven victorious fields, to throw away a hundred chances that Fortune offered with a lavish hand, to heap mistake on mistake, to be hurried against his will into battle by the imperious temper of a subordinate, and to be ignominiously routed by an enemy of scarcely half his strength. So inexplicable seemed his overthrow, that men ascribed it to the direct intervention of a higher power, that, roused to vengeance by the cry of innocent blood, had resolved to suspend the stroke of death till the sinner had drunk the cup of degradation to the very dregs.

In the cold, ruthless ferocity of their dispositions, there was but little difference between Tilly and Wallenstein. In other respects they varied as the enthusiast from the politician. Tilly, trusting in the favour of the saints, flew like a tiger full at the face of his foe—Wallenstein encircled him with the folds of a boa constrictor. The object of Tilly's attack might brave his fury again and again; but the grasp of Wallenstein was death. Tilly fought for his faith, Wallenstein for his own ambitious views —Tilly for an immortal crown, Wallenstein for an earthly sceptre. So, while in one campaign Wallenstein swept all before him with the sweep of a tornado, in another he let the war rage as it would. Entreaty, taunt,

and menace failed to draw him from the shelter of his camp. None could unravel the tangled skein of intrigue that he wove in the dark depths of his inscrutable mind. Even the assassin's dagger failed to solve the Gordian knot, and left the name at which the world grew pale to be the riddle of the historian. The intellectual powers of a mere child are amply sufficient to discriminate the essential difference between patriotism and treason; but the subtlest minds have been unable to determine whether Wallenstein was a patriot or a traitor.

Field-Marshal Count Pappenheim was but little inferior to the two generals whose fame has eclipsed his own. By a rare combination of talents he united the cunning of an Ulysses to the impetuous valour of a Mezentius. Men pointed him out in the streets as one marked out by fate for a warrior's life and a warrior's death, for at his birth a mark resembling two crossed swords was to be seen clearly traced out on his brow. Time in its onward course had all but obliterated the ominous blazon, but in the fury of the charge and the crisis of the battle it ever flashed out like a fiery star. His body, it was said, was gashed and seamed by full a hundred wounds. His fate was foretold by nature's self, yet he still rode as gallantly and blithely to battle as to bridal. Born in the same year, he fell on the same day, as Gustavus Adolphus, full of fame, though young in years, the sword of Austria and the Ajax of the war.

The armies who marched under the banners of these great chiefs bore characters as strongly marked as were those of the leaders whom they served. Every one is familiar with the portraiture of the gallant soldado of the seventeenth century, his low-crowned hat and drooping plume, buff coat, gorget and cuirass, scarf, tassettes and bandolier, a costume so noble and graceful that it seemed designed by the very genius of war for his votaries. The camps of Wallenstein and Tilly swarmed with high-mettled cavaliers, gay, careless, and defiant of death, sudden in quarrel, quick of eye, and open of hand. Vienna sent forth her gay and thoughtless sons; the Walloon lent his ponderous strength of horse and man; the German the dogged determination of his race; the Scot a valour lofty and self-reliant, tameless as the billows that burst on his own rugged shore, and stubborn as the cliffs that fling them from their giant breasts; and the Spaniard a chivalry, discipline, and renown tested by upwards of a century of warfare in the New World that his enterprise had discovered, and in the Old, which his arms had all but subjugated. Croat, Sclave, and Magyar, wild horsemen, whose trumpets had sounded alternately in the van of the Crescent and the Cross; the needy adventurer, the reckless criminal; all who owned a stout heart and a good sword, were welcome auxiliaries to the armies of Austria and the League.

Mansfeld had introduced the system of making war support war. Wallenstein carried out this principle to its fullest extent. It was his maxim that 50,000 men would live where 20,000 would starve. The stronger his force the greater its opportunities of plunder. A prince or city might bid defiance to a small body of men, but must buy off an overwhelming army. As long, then, as there were petty princes and rich and peaceful cities in Germany, so long would there be a perpetual flow of wealth to the pockets of the soldiery.

The camp was a strange and terrible sight. "Where Wallenstein's

horse treads there grows no grass," was the saying of the time. A howling wilderness piled with festering corpses, and bright with the light of blazing villages, spread for miles round his quarters. It was from the vocabulary of his camp that the word plunder found its way into our language. Another word, "marauder," is a corruption of the name of Merodé, one of Wallenstein's favourite officers. The camp was one wild scene of revel. The officers flaunted in scarlet and gold; many a well-lined purse fell to the private's share. Costly wines were broached, woman gave her smiles, and the gambler plied his trade. But when the ordinary supplies of booty failed the soldiers deserted by battalions to the standards of some more prosperous leader. The discipline, though fitful, was of the sternest kind. The gallows was a standing institution. Regiments were decimated and men strung up by the score.

In the day of battle the army was drawn up in huge unwieldy battalions ten deep, and from two to three thousand strong. Each regiment was divided into ten companies, and each company contained from two to three hundred men, one half of whom were armed with pikes, and the rest with matchlocks. Another and still more preposterous formation was sometimes adopted by the Imperial armies, and is reported, though, to my mind, hardly on sufficient grounds, to have been used by Wallenstein at Lützen. A body of 5,000 infantry was divided into 50 half companies, each 100 strong, five such half companies of pikemen, with a front of ten men each, and of course of an equal depth, being then taken as a base. A solid square was erected on this base (as represented in the diagram on Plate I.), showing a face of 50 men on each side, and a depth of the same number, and 2,400 musketeers were now ranged as a border, ten men deep, round these. The remaining 100 musketeers were then placed at the corners in little solid squares of 25 each, so that the whole arrangement looked like a huge square castle with little turrets at the angles. Of course the immediate result of this stupid arrangement was to render the pikes of the centre perfectly useless, and to prevent all but the first, or perhaps the first and second, lines of musketeers from firing a shot. As may easily be conceived, hostile artillery ploughed deep lanes through such an unwieldy mass, and unevenness of ground soon broke up the regularity of the formation. Even in the ordinary ten-deep line of battle more than half of the soldiers took no appreciable part in the engagement; but in the arrangement I have just described it is probable that not one soldier in twelve ever had a chance of using his weapons. It is true that the system of the phalanx had reached its highest point of perfection in the armies of the Empire, and that the Imperialists had hitherto been almost uniformly successful in every campaign. As yet, however, battles had been confined to the encounters of opposing phalanxes, and legion and phalanx had yet to meet in the shock of arms, and establish in a fairly fought field a decision that should be valid, not for the moment only, but to the end of time.

Wallenstein was dismissed the Imperial service in consequence of the personal animosity borne him by Maximilian, Elector of Bavaria, and head of the League, at the very moment when his services were most necessary, and the command of the combined armies had been committed to Tilly. The soldiers of Wallenstein's old army deserted by tens of thousands. In 1628 they alone had marched against Stralsund 60,000 strong.

When Gustavus Adolphus landed in Pomerania in June, 1630, the whole force of the two confederate armies could scarcely have shown so formidable a muster. The king's own army, numbering at the outset about 15,000 combatants, found itself opposed to a force of about equal strength. Gustavus's first object was to secure an effective base of operations. He was master, indeed, of the sea from the beginning, but, in order to advance, it became necessary to force the Duke of Pomerania into an alliance. By this measure he gained the assistance of a body of troops who afterwards, under the name of the White Brigade, yielded to none in their valour and their fidelity to their leader, and of several fortified posts from which he was able to extend his operations towards the interior. Before the conclusion of the year he had chased the Imperialists out of the dukedom. Tilly and Pappenheim, whose troops were quartered in Westphalia, had made no aggressive movement. The old soldiers of Wallenstein flocked to the king's camp by hundreds at a time. Important reinforcements reached him from Sweden and Scotland. He had concluded a treaty of alliance with France, and was prepared to open the campaign with an army of 30,000 men.

The Swedish regiments of infantry consisted, exclusive of officers, of 1008 or 1152 men each, divided into eight companies each of 126 or 144 men. Of the entire number two-thirds were musketeers and one-third pikemen. They were usually drawn up six deep, pikemen in the centre, and musketeers on the flanks. To resist infantry, the musketeers advanced till their fourth rank became a continuation of the first line of pikes, and then poured in their fire. To resist a cavalry charge the three first lines of musketeers fell back on the three last, thus leaving the pikemen in their turn three ranks in advance. The larger portion of the musketeers were still armed with matchlocks, the flintlock, then a modern invention, not having come into general use at the commencement of the king's enterprise, and at the same period, and until Gustavus reduced their weight, both weapons still required the assistance of the rest. The Swedish pikemen still wore helmet, breast-plate, and tassette, but the king had already deprived the musketeers of a weight of accoutrements which was at once an inefficient protection against a bullet, and an impediment to their activity in the field. In the German armies the musketeers still carried the bandolier, a belt stretching from the left shoulder to the right hip, and garnished in front with eleven little cylinders, ten of which contained a charge each of powder, and the eleventh a supply of the same material for priming, and to the extremity over the hip were attached a powder-horn and a box of bullets. The match was suspended to the little finger of the left hand, and on the march the matchlock was carried over the right shoulder and the rest in the left hand. The king superseded the bandolier and its appendages by the introduction of the cartouche box, filled, as at present, with cartridges, and did away with the rest by gradually diminishing the weight of the piece. At the same time he added to the efficiency of the pike by reducing it from its cumbrous length of sixteen feet to eleven.

Each regiment consisted of two battalions, each commanded by a lieutenant-colonel. The colonel in chief, as in our army of the present day, was almost always a general officer. A captain, lieutenant, and ensign had the charge of each company, and had twenty-four non-com-

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missioned officers under them. It was, among other things, the captain's duty always to keep the company at its full complement, and for this purpose he received, over and above his own stipend, a private's pay for every ten men actually borne on the strength. To attach the soldiers still more to the regimental colours, the ensign who had them in charge at the moment was prohibited from inflicting punishment upon any soldier, and in case of certain minor offences was allowed the privilege of publicly asking remission of the sentence, and it was the general policy of officers commanding regiments to comply with his request.

The cavalry was formed into regiments 500 or 600 strong, each divided into eight squadrons or sixteen demi-squadrons. In this branch of the service Gustavus was generally numerically inferior to his opponents. It therefore became his practice to make up for this deficiency by posting small bodies of musketeers between the different regiments of horse. But the introduction of a newer and bolder system of tactics made his cavalry formidable in a degree that was out of all proportion to its numbers. It was the manner of the Imperial cavalry to ride up close to a hostile body of infantry, pick off as many of the first line as possible with their pistols, and then charge if they could effect a practicable breach in the line, if not, to gallop to the rear and reload, while the second, third, and remaining ranks continued the attack in the same fashion. The orders to the Swedish cavalry were, that the first line should discharge their pistols right and left as soon as they could discern the whites of their enemies' eyes, taking care, at the same time, not to slacken their speed. The whole body was then to fling itself among the enemy, the rear ranks reserving their fire for close quarters. The success of this new system had the effect of restoring the character of the cavalry from the position of undue depression into which they had fallen in consequence of the collapse of the feudal system and the brilliant victories of the infantry of Switzerland and Spain. It may also be mentioned here, before turning to a different head, that Gustavus was the first after the Romans to give its due importance to military engineering. His men were all trained to the shovel and the pick. He constructed many fortified camps while in Germany; in only one was he attacked. In this case he beat off a superior force in two separate assaults. Every one of the others was pronounced by his enemies to be absolutely impregnable.

The artillery of the Imperialists was of the same unwieldy character as their discipline. By its weight and cumbrousness it was a constant clog and impediment on the line of march, and it was next to impossible to move it from place to place on the day of battle. The greater portion of Tilly's guns were 24-pounders, though 48-pounders were frequently used, and a 24-pounder required twenty horses for its own transport and twelve more for its attendant waggons. Even a 16-pounder weighed between forty and fifty hundred weight, a 2-pounder weighed ten hundred weight, was five feet and a-half in height, and required four horses. In this branch also the use of cartridges was unknown. When a gun was brought into action, a barrel of balls was placed on one side and one of powder on the other. The heads of both having been knocked off, the master gunner on one side poured in a shovel full of powder, and his companion opposite rammed a ball on top of it. Under these circumstances, artillery practice in the armies of Tilly and Wallenstein would hardly have passed muster

at Woolwich. Gustavus applied himself zealously to remedy the defects I have just enumerated. In the first place he introduced the use of the cartridge into the artillery as well as the infantry. Next, by a singular combination of brass, leather, iron, and cord, he constructed a weapon on which was bestowed the name of leather cannon, so light that it could easily be moved from place to place by one horse or a couple of men. This instrument did good service in the field, especially at Leipsic, but, as it became useless after ten or twelve discharges, it was gradually superseded by the improvements effected in the old system. The Marquis of Hamilton determined, after a series of experiments, that the weight of the guns actually in use might be materially lessened without impairing their efficiency, and Gustavus immediately put the result of the marquis's investigations into practice, and with so much success, that, while the Austrian 2-pounder, as I have stated above, weighed ten hundred weight, and required four horses, the Swedish 4-pounder weighed only six hundred and twenty-five pounds, and was moved from place to place by half the number of horses required by the other weapon. He also introduced the practice of mingling light with heavy artillery. In case of an attack, the lighter pieces remained behind to impede pursuit, while the heavy guns were drawn out of the reach of danger.

The efficiency of the Swedish artillery was well supported by the rapidity of the fire of the musketeers in the same army. Among the Imperialists the musketeers were drawn up so as to form one wing of a regiment, the other wing being composed of pikemen. Therefore, when a regiment was at full strength, its complement of musketeers amounted to 1500. Of these 150 stood in each rank. When the first rank had delivered its fire, it ran off right and left along the whole face of the wing, and passed nine files before it drew up again as a tenth rank to reload. Thus each rank had to run round 1350 of its comrades. With the Swedes the pikemen stood close, but each rank of musketeers was divided into squads of 4 or 5, each superintended by a non-commissioned officer, and each separated from the next squad by an interval of two or three feet. Thus the musketeer, after discharging his piece, had to pass only 3 or 4 others in rank and five only in file. Under these circumstances the fire of the Swedes was of course infinitely more formidable than that of their opponents.

It will be seen at a glance that the effect of all these reforms in the art of war was to substitute lightness and rapidity for weight and solidity; the legion for the phalanx; the mobility of the detachment for the inertia of the mass. Amongst the Swedes the unit of discipline was the company, among the Imperialists the regiment. But in battle the rout of a single company would be a matter of but trifling importance in all probability, while the overthrow of a whole regiment, 2000 or 3000 strong, would make a fearful gap in the line. Nor had the German commanders in general any means of repairing such a calamity, for it was their constant practice in following the order of the phalanx to draw up their armies in one long line without any reserve. The king, on the other hand, always arranged his troops in two lines, with a reserve to each. In the battle of Leipsic a large body of cavalry attempted to outflank and get into the rear of the king's first line. This attempt was at once frustrated by part of the second line and the reserves of the first, and the assailants were

driven off the field. Conversely the appearance of the king in the flank and rear of Tilly's forces in the same battle led to the capture of the whole of the hostile artillery, and to the first great victory gained by the Swedes on German soil. It is most probable that Wallenstein, profiting by the disaster of his predecessor, actually had a reserve on the field of Lützen, but still, at the very last moment, Knyphausen was able to lead an entirely fresh body of soldiers to check the advance of Pappenheim's infantry from Halle, and at Lützen, as at Zama, the last reserves decided the result of the contest. It is needless to say that the successes of the king led to the universal adoption of his system. The testimony of antiquity was confirmed, and for the second time in history the phalanx succumbed to the legion.

The king's army had doubled its strength during his six months' occupation of Pomerania. Many important military positions had fallen into his hands, and he had established a safe base for ulterior operations. But, notwithstanding his alliance with France, his political prospects were but little improved. The general rising of the Protestants, which was expected to follow his landing, had not taken place. The Protestant Electors of Brandenburg and Saxony, whose states lay directly in his line of march, were rather covertly hostile than absolutely neutral. They refused the Swedes a passage, while they winked at the transport of Imperial detachments and stores through their territories. They even signed a convention, evidently aimed at the king, by which they bound themselves, while reserving their obedience to the emperor, to resist by force of arms any attempt to violate their frontiers. The emperor, as a matter of course, respected for the present a neutrality which at once protected the march of his armies and cooped up his antagonist in a narrow and barren tract at the very extremity of his dominions.

As matters stood, the chances of success were all in the emperor's favour. It was not to be expected that Gustavus would continue to carry on the contest without a single influential ally on German soil. It was only necessary to avoid any decisive engagement, and to let matters take their course. Gustavus abandoned to his own resources must have returned to Sweden in a few months. After this the emperor might have dealt with the Protestant princes as he would. But the court of Austria was impelled by a blind passion, which drew down on its head the indignation of the whole world. A terrible calamity was needed to rouse the Protestant powers from their apathy, and it was soon given them in a scene of inhumanity and horror, happily almost unparalleled in the history of the human race.

Tilly had formed the siege of Magdeburg, which had declared for the King of Sweden, early in the year 1631. Called away by the reports of the king's progress, he left Pappenheim to continue the investment, while he himself endeavoured to force the Swedes to an engagement. Foiled in this attempt, and crippled in his resources by the loss of his magazines by the capture of Frankfort-on-the-Oder, he retraced his steps to Magdeburg, and resumed the command of the besieging army on the 30th of March, 1631.

The burghers, though torn by intestine faction, held out gallantly. They had indeed refused the offer of a Swedish garrison, but had accepted the services of one of the most experienced of the Swedish generals.

Powder soon ran low, and starvation stared them in the face. Still the mention of surrender was forbidden on pain of death. It was confidently hoped that the siege would be raised in a few days by the arrival of the king. Yet week passed after week, and still there was famine in the streets of Magdeburg, and the foe before the wall. But the spirits of the burghers were kept up by constant communications with the exterior. Their spies brought them in almost daily reports of the progress of the king. On the 9th of May the hearts of all were relieved by the report that he was already within three days' march. The intelligence was confirmed by the rapid slackening of the hostile fire. Gun after gun was withdrawn from the Imperial works, brigade after brigade was seen retiring over the plain. There could no longer be any doubt that the king had nobly fulfilled his promise. The burgher guard quitted the walls, the whole population gave itself up to the transports of the hour. At night but few of the garrison returned to their posts. The whole city was soon buried in sleep. It was the last sleep of thousands.

Tilly had actually raised the siege on the assurance of the near approach of Gustavus; but the impetuous counsels of Pappenheim prevailed over his determination. It was finally resolved that the latter general should make one more attempt to carry the works by storm, but that if he were repulsed the siege must be definitively abandoned. Pappenheim immediately retraced his steps, and attacked the wall near one of the gates of the new town at seven o'clock in the morning of the 10th May, 1631. The few defenders were soon overpowered, and the general himself was the first on the rampart. Followed by a few brave men, he dropped into the street, and opened the gate to the assailants.

Falkenberg, the Swedish commandant, and after him Schmidt, captain of the burgher guard, aroused by the noise of firing, hurried up to the point of action. It was in vain that by exertions of almost superhuman valour they succeeded in driving the stormers back to the very gates: the walls, stripped of their defenders to feed the murderous conflict raging within their circuit, were scaled on a dozen points at once; Falkenberg fell almost at their foot, Schmidt soon shared his fate, and Madgeburg fell with his fall. The arrival of four fresh regiments of Imperial infantry crushed the last hopes of resistance; by noon the whole town was in the hands of Pappenheim.

Tilly now entered the city; his troops were disposed so as to occupy all the principal points and sweep the main streets with artillery; the burghers were ordered to retire to their homes on pain of death. A terrible silence reigned over the scene as the generalissimo rode down the long lines of soldiery. The fate of 40,000 of his fellow-creatures hung on one word of mercy from his lips. To his eternal shame that word was never spoken. Silently as he came, so silently he left. Immediately on his departure the soldiers burst their ranks, and flung themselves like famished wolves on the devoted city.

And now ensued a scene at which humanity shudders—horrors which the pen dares not portray. Men, women, and children, every age and either sex, were involved in one sweeping massacre. The ferocious soldiery of Pappenheim tossed little children from point to point of their pikes, or flung them, still living, into the flames. Fifty-three women

were beheaded in a single church. The city was set on fire in several places. A terrific tempest sprang up to fan the flames, and added the horrors of a general conflagration to the atrocities of a massacre that flooded the streets with blood. It was in vain that some German officers implored Tilly to spare the lives of their countrymen, nay, offered to risk life and limb in the cause of mercy. "The soldier has made extraordinary exertions, and must not now lose his reward," was the cold, stern reply. For four days Magdeburg was abandoned to her fate. In one day 6000 corpses were flung into the Elbe. When Tilly's second entry put a stop to this scene of more than fiendish barbarity but 1,400 of the inhabitants remained alive: forty thousand men, women, and children had been swept into eternity. Of the whole city there remained but a single church and a few wretched fishermen's huts. Never had such utter ruin fallen on home of civilized men since that fearful day when the soldiers of Titus gazed from the hill of the Temple on the tossing sea of fire that enveloped the crumbling ruins of the once holy city of Jerusalem.

A loud cry of indignation and horror rose up through the length and breadth of the land. As may readily be supposed, the chief blame was at first laid on the tardiness of the King of Sweden; he felt the imputation, and vindicated his conduct in an able and convincing state paper.

No one was more thoroughly aware of the necessity of an effective base of operations than the king. On abandoning his grasp on the coast it became necessary to secure his rear, by reducing the various towns held by the Imperialists in the Duchy of Pomerania, and driving them out of the country. By the success of these operations he found himself on the frontiers of Brandenburg. The Electors of Brandenburg and Saxony had resolved to close their territories against the march of either of the contending forces, and were prepared to enforce their decision by means of an army of 30,000 men. The king felt the difficulty of the situation. It would have been in the highest degree imprudent to advance so long as it was in the power of the two electors to throw so powerful a force on his lines of communication. It would have been even more imprudent to have attacked princes whose alliance was necessary to his success. To give them a pretext for a junction with Tilly would have been little short of madness—would, indeed, have brought his army to the very verge of annihilation. He therefore determined to try in the first instance the effect of negotiation; but his request for a passage through Küstrin was met on the part of the Elector of Brandenburg by a demand for the surrender of Spandau, recently occupied by the Swedes. The king, though chafed to the soul by this instance of ingratitude, withdrew his troops from the fortress without a moment's delay. But while the elector was congratulating himself on the success of his policy the Swedish army suddenly appeared before Berlin, and called on him to decide between peace and war. The defences of the city were too feeble to resist an attack, and the rapidity of the king's movements had frustrated all hope of an intervention on the part of the other elector. An accommodation was at last effected by the mediation of the ladies of the electoral family; the fortresses of Küstrin and Spandau were given up for the space of a fortnight to the king, and his way was thus opened up to the frontiers of Saxony. At this point the only available road was closed by a body

of Saxon troops; any advance in this direction would have led to an immediate engagement. Gustavus had come to fight for, not against, the elector: the permanent hostility of Saxony would have rendered it impossible for the Swedes to extend their operations into the heart of Germany, where the king was sure of an enthusiastic reception. Gustavus was therefore obliged to enter on a second negotiation, and while it was dragging on its tedious length received the terrible intelligence of the fall of Magdeburg. In the bitterness of his soul he avowed his intention of abandoning the war. Fortunately for his glory, he was roused by a letter from the Elector of Brandenburg, demanding, in a paroxysm of terror on account of the success of Tilly, restitution of the fortresses of Küstrin and Spandau, the term for which they were lent to the king having now expired. The king, roused to indignation by the insolence of this message, marched again against Berlin, and, by the threat of an immediate assault, forced the elector to an alliance offensive and defensive; this done, he entrenched himself strongly at Werben, about seventy miles north of Magdeburg. Here Tilly marched against him. But the generalissimo's career of triumph had culminated at Magdeburg. He was repulsed in two desperate attacks, and, having exhausted the surrounding country, was forced to retreat with a loss of 6000 men.

The emperor was now weary of the neutrality of the Elector of Saxony. Elated by the success of his army at Magdeburg, he conceived himself irresistible in the field. Accordingly he ordered Tilly to effect a junction with the division of Fürstemberg, and march into the electorate. The generalissimo was only too happy to have an opportunity of quartering his troops in the rich and untouched fields of Saxony. He marched forthwith on Leipsic at the head of an army of 40,000 men. The elector protested in vain; Tilly continued his march, plundering, burning, and slaying as he went. At length, after a pitiable attempt at bravado, and an equally pitiable display of vacillation and terror, the elector threw himself into the arms of Gustavus, and had the mortification to find his outpourings of enthusiastic admiration and inviolable attachment received with the coolest indifference. In answer to his frantic appeals, the king, who had every cause to distrust his fidelity, demanded concessions of the most humiliating character. The elector, on his part, was only too willing to grovel in the dust before his expected deliverer. The king's demands were not merely acceded to, but even exceeded. On receiving this proof of the earnestness of his new adherent, Gustavus gave way at once to the natural nobility of his temper, and, stipulating only for the loan of a sufficient sum to supply his army with one month's pay, broke up his camp and directed his march on Saxony.

Now occurred one of the most critical junctures of the war. Tilly lay at Leipsic with about 40,000 men. The armies of the elector and king, each about 18,000 or 19,000 strong, lay at a distance of about two marches from him and from each other. From his position and his enormous superiority in force he might have dealt his blows to right and left in quick succession, and with terrible effect, or at all events have endeavoured to hold the king at bay for twenty-four hours with the division of Pappenheim or Fürstemberg, while he overwhelmed the Saxons with the rest of his army. Subsequent events showed that the forces of Saxony

would have proved anything but formidable antagonists. The Tilly of bygone years would not have hesitated for a moment; but the Nemesis of Magdeburg hung over the soul of her destroyer. The general who had declared that in a match with so skilful a player as Gustavus Adolphus it was dangerous to lose the most insignificant piece, now all but threw up the game. The king without meeting the slightest opposition effected a junction with the Saxons at Düben, about ten miles in front of Tilly, on the 4th September, 1631.

Gustavus had now many reasons to force an action. His army was as strong as ever he could hope it to be, while a few days would bring large reinforcements to his enemy's camp. His only fear lay in his doubts of the steadiness of the raw levies of Saxony. Should they prove unequal to the assault of the veterans of Tilly, the Swedish army might be called upon to defend its positions against an enemy of more than double its strength. The elector used all his eloquence in the council of war against the possibility of such a contingency. It is not likely that Gustavus had any great respect for the arguments of his ally, still, after mature deliberation, he issued the order to advance.

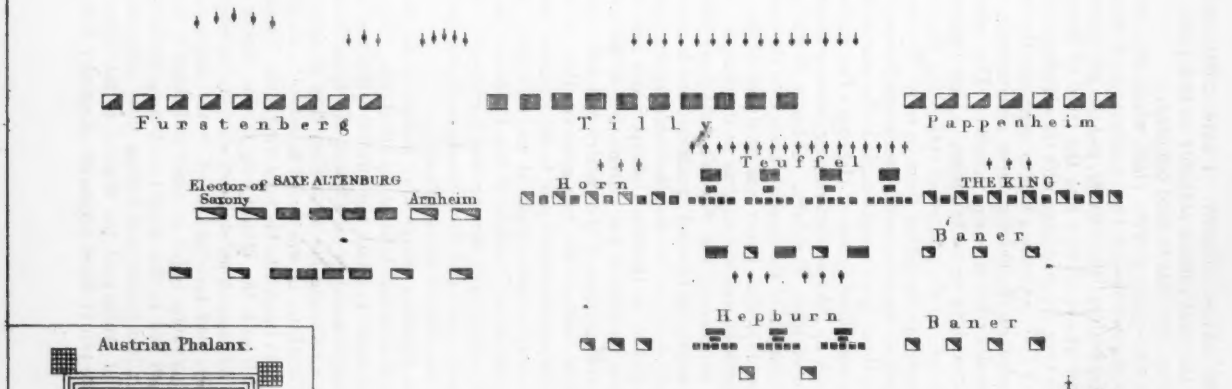
On the other hand, Tilly was unwilling to commit himself to the chances of an action before the arrival of the strong corps of Tiefenbach and Altringer. But the impetuosity of Pappenheim triumphed over the scruples of his leader. Yet men said that many an omen of ill had filled the superstitious mind of the general with gloomy anticipations of defeat. Perhaps his foregone conclusion as to the hopelessness of success may have contributed to his failure on the great day of trial. All his former military ability seemed to have deserted him at this juncture, and the disposition of his army was such as almost to have ensured his defeat.

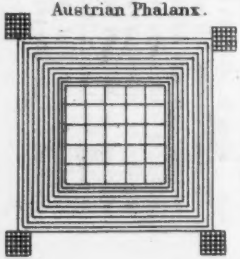
His position on the slope of a low range of hills overlooking a wide and level plain was formidable enough, but he managed to neutralise all its advantages by the grossness of his errors, both of omission and commission. He omitted the most favourable opportunities of checking the march of the king through the single narrow pass that led to the battle-field. He permitted him to deploy calmly and leisurely into line. He drew up his own forces in one long line of heavy unmanageable brigades. There was not so much as a single regiment in reserve, and, worse than all, the whole of his artillery was posted on the hills far in rear of the main body of the army. It is quite plain that beyond a certain point any forward movement of the Imperialists would effectually silence the fire of their own guns; nor could these latter, cumbrous and clumsy as they were, be easily moved down to support an advance. And lastly, there was no force whatever at hand to repel an attack on this arm by any hostile body that might penetrate into the rear of the Imperial army.

The accompanying plan (Plate I.), which has been constructed from a comparison of the histories of Bulow and Chapman, and the contemporaneous details of the Swedish Intelligencer, will show the dispositions of the two contending hosts on the eventful morning of the 7th of September, 1631. There is very great uncertainty as to many of the movements on both sides throughout this memorable day. The art of despatch-writing was then only in its infancy, and few of the hands that grasped the sword were conversant with the use of the pen. The whole history of the battle, in

BATTLE OF LEIPSIC, 7th Sept.r 1631.

ORDER OF BATTLE 12 NOON.





Imperialists

Saxons

Swedes

KLEIN PODELWITZ

J R Jobbins.

fact, is involved in the deepest obscurity. I have endeavoured to follow what seemed to me the most reliable authority on each point. If I have erred, I have done so at all events in good company.

Between the two armies lay a wide plain, which had been recently ploughed, and was now parched by a long continuance of drought. The sun and the wind were both in Tilly's favour, and the latter, sweeping over the fields, drove dense clouds of dust into the faces of the Swedes. A little before noon the king, in accordance with the chivalrous spirit of the time, sent a herald to Tilly, requesting him to commence the battle. The generalissimo responded by discharging three cannon-shots, which were answered by the Swedes with the same number. The cannonade now became general, and was kept up for two hours. Then Pappenheim drew his cavalry off to the left, for the purpose of outflanking the Swedes, and doubling up their whole line by taking them in rear. To counteract this design Baner, bringing up the seven cavalry regiments forming the reserve of the first line, drew them up at a right angle to the rear of the Swedish right. The line was completed by one of Hepburn's foot regiments of the second line, which took up the space intervening between Baner's extreme right and the village of Klein Podelwitz. Pelotons of musketeers were placed between the intervals of the Swedish horse, and the movement was effected with such rapidity, that Baner was firmly established in his new position before Pappenheim was able to come to the charge. As he came on with his wonted impetuosity, the Swedish musketeers delivered their fire with fatal effect among his crowded squadrons; and immediately afterwards Baner's cavalry broke in on his disordered ranks. At the same time the infantry regiment of Holstein Gottorp, which had followed the Austrian general from its post on the extreme left of the centre, being outstripped by the rapid advance of the cavalry, was left exposed in the middle of the interval between the two armies. Here it long made a gallant resistance with matchlock and pike to the repeated charges of the cavalry of Finland, but, its ranks being at length broken by the heavy fire of the Swedish artillery and musketeers, the Finlanders charged home. The Holsteiners still resisted with heroic courage, even after this disaster, but the Swedish sabres plied well their bloody work, and the whole regiment fell almost in the order of its formation.

While Baner was repulsing charge after charge by the tactics I have described, a terrible disaster had befallen the allied left. Tilly, in the first instance, led his own centre to attack the Swedish centre and left; but, his own batteries becoming masked by his advance, and being himself received by Torstenson with a withering fire of artillery that ploughed deep lanes through his heavy battalions, he was forced to retire to his original position. Here he attached himself to his right wing under Fürstemberg, and both generals now fell with the utmost fury on the Saxon army. The resistance here was for some time stubborn enough, but when the best of the Saxon cannoniers had been picked off by the Imperialists, and the long line of glittering sabres rolled on closer and closer to their van, they lost heart, broke, and fled in the wildest confusion, headed, as might be expected, by their gallant elector, and leaving their camp, and the whole of their equipage and artillery, at the disposal of the victors. Arnheim contrived to extricate two or three regiments of cavalry from the general

rout, and to lead them to a post of security behind the ranks of Gustavus Horn; the rest burst away with a celerity that might have been rivalled, but hardly exceeded, by a pack of beagles.

The position of the Swedish left was now critical in the extreme. Tilly in his pursuit of the Saxons had penetrated far into their rear, and, had this advantage been promptly followed up on his part, the Swedes might have had to mourn a signal defeat. But here one of the most fatal errors of the Imperialist system of warfare, that of allowing an army to degenerate into a band of plunderers, came in to thwart all his endeavours. The flight of the Saxons had left their camp exposed to the rapacity of the victors, and these latter, breaking their ranks, flung themselves like wolves on their prey. In a few minutes an organized body of at least 20,000 men had melted into a mere mob. It was only after a considerable interval of time that their generals were able to draw 8,000 or 9,000 men round their banners, and, covering these by the fire of the captured artillery, they led them direct against the Swedish left.

Gustavus Horn, one of the best generals of the age, had, however, improved the respite so unexpectedly granted him to the very utmost, by retiring the forces under his command till they formed an obtuse angle with the centre. The king also hurried up to the spot, and by his orders Hall's three regiments of cavalry attached themselves to the extreme left of the new position, and were there joined by the two remaining regiments of infantry of Hepburn's brigade; the centre regiment of the right wing was now ordered up to complete the line, and in a few minutes made its appearance at its appointed post.

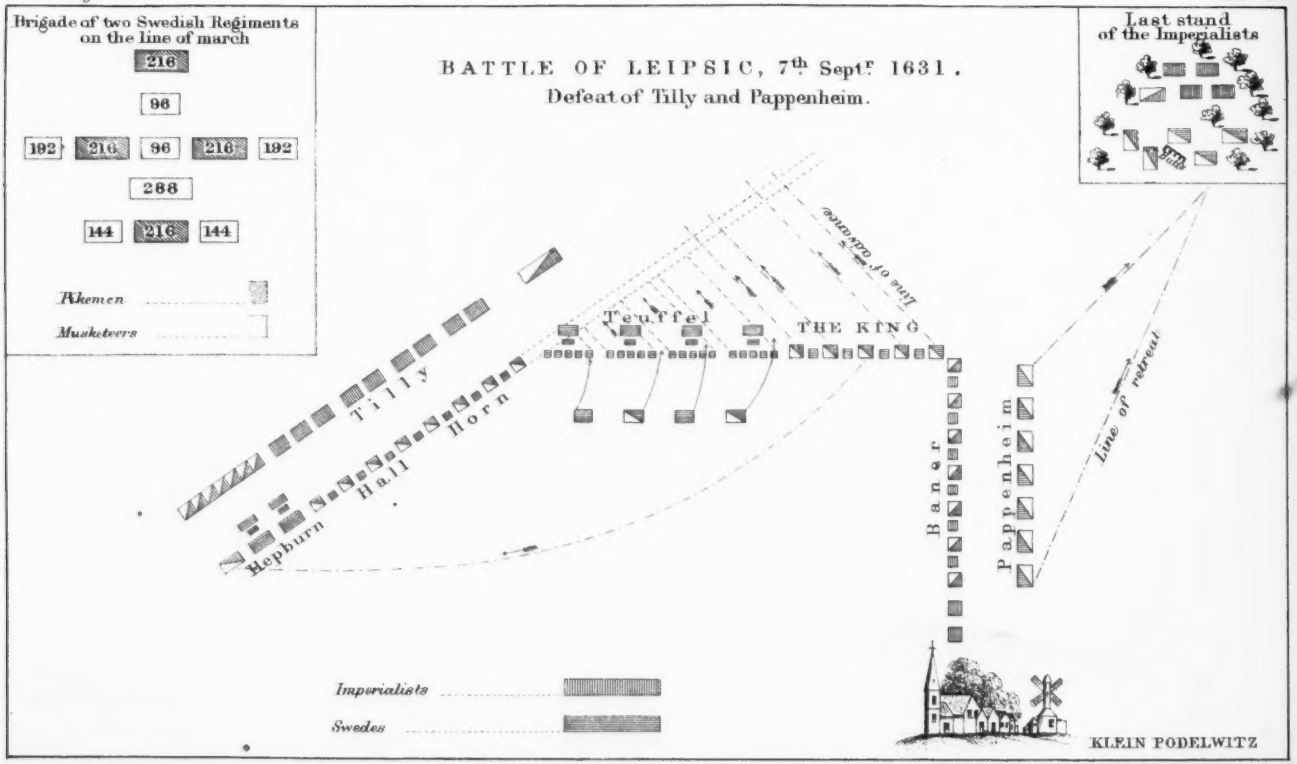
And now ensued a struggle grim and great: pike crossed pike, sword clashed with sword, and man grappled with man; fiercely and sternly they fought, as wolf with wolf, as ship with storm, as river-flood with tide; regiment after regiment plunged into that wild tempest of fire and steel; regiment after regiment staggered back, torn and bleeding at every pore. Collenbach's Swedes perished man by man in their ranks as they had stood; Hall fell, as a soldier should, the first in a fiery charge. The legions of Austria rushed on again and again in one long line of glittering steel; again and again they reeled back, pierced through and through by the murderous fire of their foes. Faster yet thinned the Swedish ranks, but they still repelled every assault with the high-toned valour of a veteran army in whose breasts the lustre of a hundred victories has effaced the conception of defeat. Reducing their ranks to three deep, they still showed an impenetrable front, and poured in a fire that swept through the hostile ranks like the brand of a destroying angel. Meanwhile the king, by a masterly movement, decided the result of the day. Informed by Baner that Pappenheim after seven desperate charges had been driven in an eccentric direction from the field, and placing the utmost reliance on the persistence of the obstinate resistance of Hepburn and Horn to the dense masses of the enemy, he took the extreme left of his centre as a pivot and wheeled his troops round on this, so as to change the disposition from the two sides of an obtuse angle to a right line extending obliquely across the plain. By this magnificent manœuvre he rolled the detachments still occupying the enemy's original line of battle one upon the other, chased them in the utmost disorder from the field, carried

To face Page 330.

Pl. 2.

Last stand

Brigade of two Swedish Regiments on the line of march


Brigade of two Swedish Regiments on the line of march
216
96
192
216
96
216
192
288
144
216
144
Pikemen
Musketeers
BATTLE OF LEIPSIC, 7th Septr 1631.
Defeat of Tilly and Pappenheim.
Last stand of the Imperialists
Line of advance
Teuffel
THE KING
Tilly
Horn
Hall
Hepburn
Baner
Pappenheim
Line of retreat
Imperialists
Swedes
KLEIN PODELWITZ

battery after battery, till the whole hostile artillery had fallen into his hands, and immediately brought it to bear on the rear of the Imperialists. The turning point of the battle had now come. Arnheim's Saxons plucked up heart of grace to charge the enemy in flank. Detachments from the Swedish right and centre came up rapidly on the rear of the enemy, already suffering severely from the fire of the artillery that had fallen into the hands of the king. Horn seized the moment of Arnheim's success to rush on with his whole line, and the Imperialists wavered, broke, and fled before his charge. Four regiments of infantry and one of cavalry alone sustained the ancient reputation of the Imperial arms. Closing their ranks, they burst through the circle of their enemies, gained a small wood in rear of Tilly's first position, and held it with heroic valour against all the efforts of the king in person till the shades of evening fell. Then, reduced to 600 combatants, they took advantage of the darkness of the night to retire from the position they had so long and so gallantly maintained.

So was fought the famous fight of Leipsic. The conquered army melted away into a mere mob. Eight thousand of their number were left upon the field; the whole of their artillery, as well as that captured from the Saxons, more than a hundred standards, and 500 prisoners, fell into the hands of the king. The loss of the Saxons was estimated at 2,000, that of the Swedes probably did not fall short of 1,500.

Material trophies were, however, the least valuable results of this glorious day. Not only had a victory been won, but a revolution achieved. The Imperialists, with every advantage of position and numbers, had been unable to hold their own. The legion and the phalanx after the lapse of centuries had met again in hostile array. Of the legion not a rank had been broken, of the phalanx but 600 had retreated with untarnished honour, and but 2000 presented themselves at headquarters on the night that succeeded the battle.

The king's movements during the next few months are more important in a political than in a military point of view. Between September 1631 and April 1632 he received the submission of almost all Germany between the Elbe and the Rhine, the Danube and the North Sea. He was everywhere hailed by the populace with tumultuous joy. The Protestant states of the empire attached themselves enthusiastically to him. The outlying territories of the League fell into his hands. Bohemia was conquered by the Saxons. Creuznach yielded to the chivalrous daring of Lord Craven, Donauwörth to the martial genius of Hepburn. Nüremberg, the richest and most powerful of the free towns of Germany, became the king's most devoted ally. Tilly, in consequence of superior orders, was forced to abstain from offensive operations, and to confine himself almost entirely to the re-organization of his army. Swedish detachments moved about in his vicinity with the most perfect impunity; even the king once gave him an opportunity of striking a blow with the greatest probability of a successful issue, but still his urgent request, urged almost with tears in his eyes, to be allowed to deviate from the cautious system enforced on him, met with a short and decided refusal. At length when the king, having destroyed all the outlying dependencies of the League, manifestly showed his intention of striking at its heart, the veteran was recalled to

the defence of Bavaria, the land of his nativity, and, taking up a position on the right bank of the Lech, between Augsburg and Rain, and breaking down all the bridges and seizing all the boats on the river, on the very verge of his fatherland, and at the head of the last reserve of his faith, awaited with a soldier's joy the approach of his antagonist.

The River Lech, ordinarily an insignificant stream enough, but now swollen by the melting of the winter's snows into a furious torrent, here swept round a point of land in the shape of an isosceles triangle, of which the vertex was turned towards the enemy, and the base formed by a small but rapid offshoot of the main stream. The legs of the triangle were lined with heavy batteries, behind these was a deep wood, still further in the rear a strong breastwork held by a large body of musketeers. Behind this again was the little stream just referred to; then came a huge redoubt, garrisoned by the bulk of Tilly's forces, and commanding the whole position by its fire. To the rear of all these extended a range of heights on which the army might form again if forced to abandon the shelter of their entrenchments. Finally, from the conformation of the ground, reinforcements could be despatched to any point along the chord of an arc, while the enemy's movements must be made round the circumference.

Gustavus Adolphus came up in force on the 3rd of April, 1632, and immediately undertook a close reconnaissance of the enemy's position. His eagle glance at once detected an oversight that utterly marred the efficiency of Tilly's scheme of defence. He saw in a moment that the generalissimo had entirely overlooked, or never attached the slightest importance to the fact, that the Swedish bank of the river was about ten feet higher than his own. To prevent Tilly's becoming sensible of this error, he contrived to withdraw his attention by various feints on the remoter portions of the line of defence, while by quietly taking possession of this post he secured at once a commanding elevation and a point from which he could direct a converging fire on the enemy. The whole Swedish army was trained to engineering operations, and, working on this occasion under the eye of their sovereign, they threw up during the night a formidable chain of earthworks, which, before dawn, were mounted with 72 heavy pieces of ordnance in three batteries, bearing respectively on the vertex and the two sides of the triangle. As soon as the light would permit, they opened fire. Their balls, crossing each other in three directions, swept everything before them, effectually preventing the despatch of reinforcements from the rear, and, tearing huge branches off the trees, flung them among the Imperialists, where they bore down whole ranks at a time. The enemy replied with vigour, but from the lower level of their batteries their shot generally struck the bank or passed over the heads of the Swedes. It so happened, also, that the wind was blowing fresh from the Swedish to the Imperial camp, and the king, ever alive even to the most trivial point in his favour, forthwith ordered large fires of wet wood and straw to be kindled all along the front of his line, and the smoke from these and the artillery floating across the river, soon enveloped the Imperialist lines in dense clouds of vapour. Under this cover a small body of Swedes crossed the stream from their own right, and, unperceived by the enemy, threw up a triangular breastwork, of the kind then called a sconce, as well for their own protection as to serve as a *tête de pont*. A

bridge had meanwhile been prepared, and was thrown across during the night, and the whole army received orders to prepare to cross over on the following morning. But the passage was already won without their knowledge. Tilly had fallen mortally wounded about noon, and with him the confidence of the army. Any further resistance was intended merely as a cover to a foregone resolution to retreat. The Duke of Bavaria, who had succeeded to the command, led the army out of the entrenchments under the shade of night, and finally, acting on the dying advice of the generalissimo, abandoned his capital and his territories to the victor, and seized the important city of Ratisbon, behind the strong fortifications of which he was not only secure against any sudden attack on the part of the king, but was placed in the most favourable position for covering the route of the army that was fast assembling under the banners of Wallenstein on the frontiers of Bohemia.

After the battle of Leipsic the Imperial Court had again opened negociations with this great commander, then living in sullen retirement, but in more than royal splendour, on his vast Bohemian estates. After a long negociation, in which the pride of Vienna was humbled to the very dust, he at length accepted the command of an army to be raised in his own name, to be officered by his own creatures, and to be as absolutely under his own control as the Swedish forces were under that of their own sovereign. The urgency of the case in time overcame the scruples of the Imperial advisers, and Wallenstein was empowered to open recruiting places in all parts of the Austrian dominions, and in three months found himself at the head of an army of 40,000 seasoned soldiers. With this force he drove the Saxons out of Bohemia, forced the Elector of Bavaria not merely to join him with his army, but even, to the inexpressible chagrin of the latter, to submit to his authority as generalissimo, and then, turning the heads of his columns westward, marched straight on the free city of Nüremberg, the most devoted of the allies of the king.

Wallenstein's plan of operations was boldly and ably conceived, was indeed of the very highest order of strategy. The king, conducting a campaign in lands which had been but recently subjugated, and in many of which there existed a party strongly opposed to his authority, had been compelled to divide his forces into seven corps d'armée. His left wing rested on the shores of the Baltic, his right on the eternal snows of the Alps. A hundred and twenty thousand men served under the standard of Sweden; his opponent could muster but half the number; yet with these he was about to throw himself in overwhelming strength on the most vital point of the Swedish line, threatening to divide their whole army in two, and to intercept the king's communications with his own country. So ably were his measures conceived as to leave Gustavus no choice between hurrying up to the defence of Nüremberg with whatever forces he could call round him at the moment, and abandoning the contest. It was hardly to be expected that, if Nüremberg should prove a second Magdeburg, even the most devoted of the king's allies would feel themselves bound to keep faith with a general whose cautious tactics had led him to prefer his own safety to a march through friendly countries to the relief of a great and flourishing city, whose only error had been its entire devotion to his cause. The soundness of Wallenstein's reasoning was proved by the result.. The

king, seeing at once the critical nature of the juncture, arrived almost unattended in Nüremberg, marked out the limits of an entrenched camp, exhorted the burghers to strain every nerve as well to complete it according to the plans he furnished as to surround their city with walls, promising at the same time to return to them in a few days with as imposing a force as he could muster. The citizens carried out the king's recommendations with spirit and energy. Several thousand labourers were at once set to work. On the seventh day after the digging of the first trench the king's army, 16,000 strong, entered the entrenched camp; on the fourteenth the works were reported to be fully completed.

Fortunately for the city, Wallenstein's rate of progression at this crisis was not remarkable for its rapidity. His inactivity was probably a part of his general plan, and was assumed for the purpose of giving the king full time to fall into the trap laid for him, and of forcing him to risk a battle before Nüremberg with an enemy of nearly four times his own strength. His own boast, indeed, while on the march, that four days would show who was to be master of the world, he or Gustavus Adolphus, seems to point irresistibly to this conclusion, and his subsequent conduct to show how little he was prepared for the barriers opposed to his progress by the vigorous and rapid measures of the King.

The famous camp of Nüremberg, the Torres Vedras of Protestant Germany, formed a vast circle round the city; was defended by a chain of redoubts, batteries, and lunettes, mounted with upwards of 300 pieces of artillery, and held by an army of 16,000 disciplined soldiers, who might at need receive considerable assistance from the city itself, the whole youth of which had been organised, and was being rapidly trained to arms. It was watered by the River Pegnitz, which divided it almost into equal portions, and supplied with the necessities of life by the magazines of Nüremberg, which had been stocked with a full year's supply of provisions, and indeed for many weeks continued to send from 40 to 50,000 pounds of bread daily into the camp. Finally orders had been sent to Oxenstjerna, chancellor and general of Sweden, to collect all outlying detachments of the army, and hurry up to Nüremberg with every available horse and man.

The army of Wallenstein, fully 60,000 strong, arrived long before the full completion of the Swedish works of defence. His lieutenants, taking into account the great disparity of numbers between the forces, and the inadequacy of the king's means to supply every portion of so vast a circle of fortifications with a competent garrison, urged an immediate attack. But even Wallenstein's resolution failed before that grim array of earthworks. "We have had enough of battles," said he, "let us now try a campaign of famine." He accordingly entrenched himself on and at the foot of a series of heights, about four miles to the west and south-west of the king, and there patiently awaited the result.

And now ensued one of the most terrible struggles recorded in history. Two armies, the total numbers of which, before the conclusion of the contest, amounted to 120,000 men, independently of the population of Nüremberg, swollen to nearly the same number by the influx of the inhabitants for many miles round, sat quietly down to test each other's endurance of pestilence and famine. Strange to say too, the originator of this fearful

experiment seemed to be the very one who would suffer most from its effects. The city of Nüremberg, in spite of the vast numbers dependent on its resources, was long equal to every demand. On the other hand, Wallenstein had no magazines of any importance, and was obliged from the very first to depend almost exclusively on the surrounding country for his supplies, and, as this became exhausted, to send out foraging parties in circles, whose diameters increased sensibly every day, while the king, from a desire to bear as lightly as possible on the devotion of the faithful city, endeavoured also to procure from the same source the largest possible proportion of the food requisite for the subsistence of his army. As a natural result, the whole district became a scene of desperate encounters, in which success was generally on the side of the Swedes. One immense convoy of upwards of 12,000 cattle and 1,000 waggons fell into their hands after a combat that assumed almost the proportions of a battle. Famine now began to rear its head in the camp of Wallenstein, and pestilence went with it hand-in-hand. The king's army was indeed far from free from contagious disorders, but famine as yet there was none.

On the 15th day of the campaign of famine, Gustavus was joined by his long-expected reinforcements, and now found himself at the head of an army of 70,000 men. But this formidable accession of strength brought with it its perils as well as its advantages. At this point the resources of the heroic city broke down. There were neither sufficient mills to grind nor ovens to bake the daily bread of upwards of 200,000 men, women, and children. Famine now began to rage as fiercely in one camp as in the other. It is impossible to state Wallenstein's loss; but that of the Swedes was from 1,200 to 1,400 a-week. Gustavus, sick at heart of these scenes of misery, offered battle again and again; but Wallenstein, though suffering still more than his antagonist, refused to leave the shelter of his entrenchments. At length the king's patience gave way, and, on the 23rd of August, 1632, the fifty-eighth day of the campaign, leaving his camp in charge of the militia of Nüremberg, he marched out, determined to force an engagement at all hazards.

Early on the following morning, the Swedish army drove in the Austrian outposts, and marched direct on the camp. Wallenstein's centre was posted on a range of heights between the rivers Biber and Rednitz. The hill and crumbling ruins of the castle of Altenburg formed the key of the position, and were protected against a hostile attack by deep trenches, redoubts, barricades, and palisades, and were mounted with a hundred pieces of heavy artillery. The only approach was by a tongue of land, so limited in extent, that not more than 500 men could advance at any one time to the attack, and the defence of this passage was entrusted to the approved valour of a body of 500 Scotch and Irish musketeers, under Captains Gordons and Butler. These choice troops held their own with a courage that has never been surpassed. Battalion after battalion, the flower of the Swedish army, rushed up almost to the very muzzles of their pieces, battalion after battalion recoiled under their steady, rapid fire. But every success diminished the number of the defenders, while the attack was constantly fed by fresh supplies from the rear. At length the Swedes burst through the enfeebled ranks of their antagonists, and forced their way to the very foot of the entrenchments. Here they were met by

a murderous front and flanking fire, to which they were unable to make any reply. It was no longer a battle, but a massacre. It was in vain that, with unrivalled courage, they attempted to hew down the palisades, or even to tear them up with their hands; in vain that regiment succeeded regiment in the bloody work from the vanguard to the last reserve. After a combat of ten hours' duration, the king was forced to withdraw, with a loss of 2,000 men. A single gleam of success had indeed relieved the disasters of the day, where Duke Bernhard of Saxe Weimar, the favourite lieutenant of the king, had carried a height that commanded the old castle. But even here fortune proved false, for the ascent being found impracticable for artillery, the duke was ordered to retire at nightfall. The command was conveyed to him by Sir John Hepburn, of Athelstaneford, the hero of Leipsic, who, though present only as a spectator, having quitted the Swedish service a day or two before, in consequence of a quarrel with the king, could not find it in his heart to refuse a service of danger at the urgent request of his old and once-loved leader.*

The Swedes withdrew, sadly and silently, to their camp. They had suffered their first repulse, and, for the first time, felt the bitterness of defeat. Wallenstein, on the other hand, had justified the high value he had set on his services, and, for the first time for upwards of two years, had dispelled the gloom of the court of Vienna by the strange tidings of a victory.

Gustavus remained a fortnight longer before Nüremberg, but then pity for the faithful city and valiant army that were pining away under the combined influences of pestilence and famine overcame his resolution. On the seventy-second day of the campaign he again offered battle, nay, even tempted fortune by marching his army almost round the hostile camp in the vain hope of luring Wallenstein to the encounter. The generalissimo looked on calmly as regiment after regiment filed by his inaccessible post. Enough of battles had been fought, and he had succeeded in the campaign of famine.

The king, leaving a strong garrison in Nüremberg, now marched into Bavaria for the purpose of reducing the few towns that still held out for the elector. From thence he was suddenly recalled to the scene of his former triumphs.

Wallenstein, possibly for the purpose of intimidating the elector by the actual presence of danger into an alliance with the emperor, had taken

* A few words as to the after-fate of this gallant officer may not be out of place. After resigning his Swedish commission, he was appointed to a high command in the army of France, and subsequently became colonel-in-chief of the Scotch regiments transferred from the Swedish to the French establishment. While serving in this capacity, he fell mortally wounded at the siege of Saverne by the side of Henri de la Tour d'Auvergne, afterwards known to history as the great Turenne. The baton of Marshal of France, at that moment on its way, arrived only in time to be placed on the hero's bier. His Scotch followers, transferred to this country in the reign of Charles II., were embodied in a regiment that has since upheld the glory of England for two centuries in every quarter of the globe, with a courage that no peril could daunt. Long as the fame of England lives, long as there is honour for discipline, valour, and endurance, long as the historian's page and the poet's song glow with the memories of the deathless brave, in lowly cottage and in lordly hall there will be warworn veterans to boast that the flame of valour shone no more brightly in the breasts of Hepburn and his companions than in their military descendants of the present day, the First or Royal Regiment of the Line.

the opportunity of leading his army into Saxony during the absence of the electoral army in Silesia. His army behaved on the present occasion with even more than their accustomed cruelty. The fields were plundered, the villages burnt, and the peasants murdered all along the line of march. In his distress the elector appealed again to Gustavus, and was not deceived in his estimate of the generosity of his ally. The king hurried up to Nüremberg at the head of a small body of cavalry, dispersed the Imperialist detachments in the neighbourhood, and, having thus provided for the safety of the city, withdrew the greater portion of the garrison, and passed, by forced marches, towards the scene of danger. Reinforcements flocked to his standard from all quarters, and, on his arrival at Naumburg, he found himself at the head of 20,000 men.

Wallenstein had thus a second time diverted the course of war from the territories of the League; and now, for the second time, found himself, though inferior in force on the whole, decidedly superior on the point of action. Changing his tactics, he now marched straight on Naumburg at the head of an army of 40,000 men and offered the king battle, which the latter in his turn refused, seeming at the same time so busily employed in the construction of an entrenched camp, that Wallenstein, fully persuaded that his opponent had resolved on a repetition of the campaign of famine, not only gave up all idea of any further active operations at so advanced a period of the year, and put his men into winter quarters, but even yielded to Pappenheim's entreaties to be allowed to march with nearly half the army to the relief of Cologne, then hardly pressed by the forces of Holland.

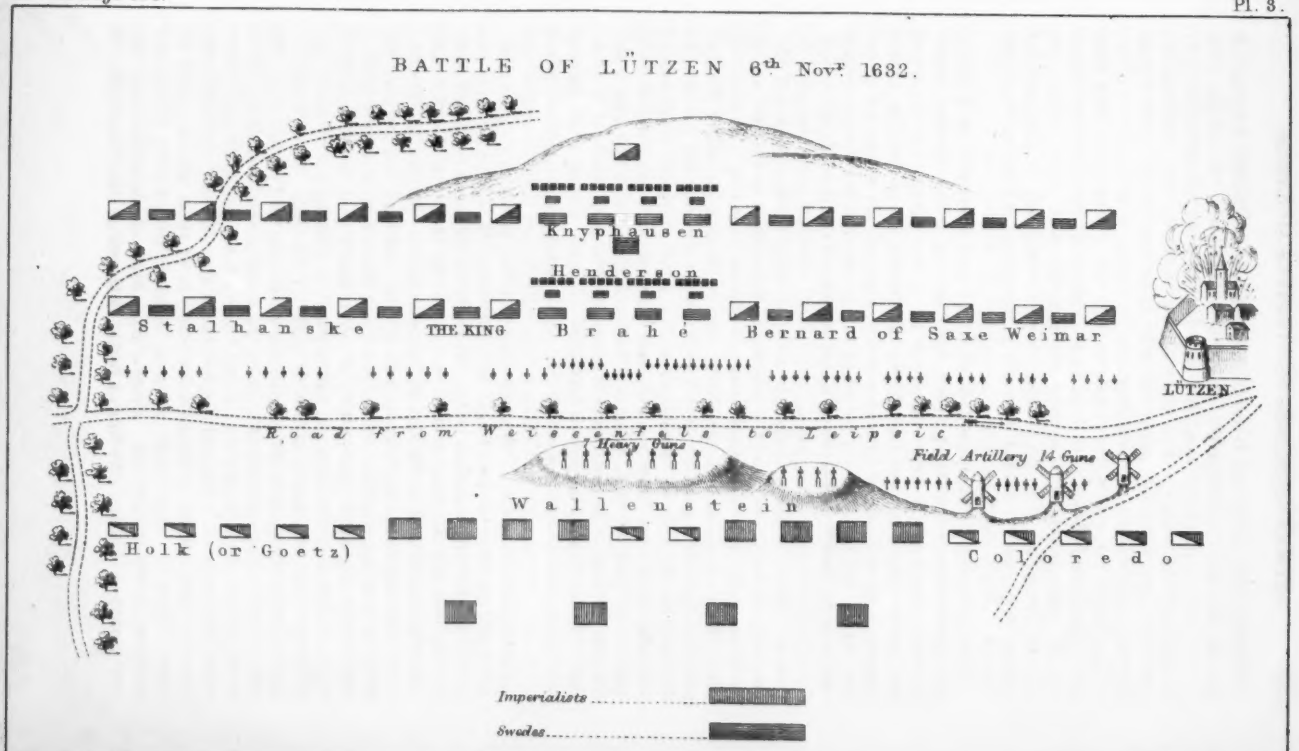
An intercepted letter from Count Colloredo betrayed the intelligence of this movement to the king, while almost at the same time he received information of Wallenstein's retirement into winter quarters in the neighbourhood of Lützen. "Verily," said the king, "the Lord hath delivered him into my hand." He immediately broke up his camp, and marched straight against the enemy.

Three cannon-shots from the tower of Weissenfels, where Count Colloredo kept watch and ward, announced to Wallenstein the approach of the king. His cool, clear, intellect rose at once to the level of the crisis. Orders were issued without a moment's delay to all his outlying detachments to fall in on the main body; and Isolani was despatched with a large body of cavalry to retard the progress of the enemy to the utmost. Messengers were also sent off in hot haste to command Pappenheim to retrace his steps and hurry up with his whole force. A position of considerable strength in the neighbourhood of Lützen (see Plate III.) was selected for the scene of action. As corps after corps came up it was marched off to its appointed station, till every favourable point along the whole line was manned by an adequate garrison. All night long mattock and spade were plied with energy and skill, till positions originally weak acquired all the elements of strength, and those that were naturally strong became almost impregnable. Hour after hour fresh accessions of strength poured into the camp, till the generalissimo, fully convinced of the completeness of his dispositions and fully confident of his ability to hold out till the scale should be turned in his favour by the arrival of Pappenheim, at length gave his wearied army the welcome signal of repose.

The treachery or incompetence of their guides impeded the progress of the Swedes far more than the opposition of Isolani. At length, after much tedious wandering to and fro, they found themselves at nightfall in presence of the enemy. The various corps took up their positions in order of battle, the whole army was ordered to stand to its arms before daybreak, and the attack to commence at the rising of the sun.

The king's order of battle varied but little from that which had been so successful at Leipsic. He drew up his army in two lines with a reserve to each, and intermixed his cavalry with musketeers as before. The high road from Weissenfels to Leipsic ran in front of his line at a distance of 400 or 500 yards. Behind this, but rather nearer to the road, lay the bulk of the Imperial army.

The disposition of Wallenstein's army remains a mystery to this day. My plan is derived from the Swedish Intelligencer, and shows the appearance that the Imperial army presented to an eye-witness on the day of the battle. By a manuscript plan in Wallenstein's own hand it appears that his infantry marched in twelve divisions to the field on the eve of the encounter. Eight of these, according to the Swedish Intelligencer, were visible in the first line. Following a valuable hint of the Rev. Mr. Chapman, I have adopted this arrangement, and placed the four other brigades in reserve. It is, however, only fair to state that the correctness of this view may be impugned, that the position of the reserve is founded merely on guess-work, and the whole must be simply taken at its value. It seems, however, almost impossible to suppose that a general of Wallenstein's ability could have repeated Tilly's error in drawing out his army in one long line without any reserve, or, as is generally reported, have massed his infantry in five huge squares, each flanked by a sort of turret of musketeers, four of these squares forming a diamond in the centre, and the fifth lying at some distance on the right. The very names of Wallenstein's lieutenants on the day of battle are as much a matter of question as the disposition of his forces. Some authors assign the command of the left wing to Holk, others to Gœtz. It is well known that the former was a considerable distance in the rear a day or two before the engagement, and I am therefore inclined to give this honour to Holk, who certainly was always present with the main body. The only thoroughly ascertained facts, indeed, as to the Austrian order of battle are the stern realities that presented themselves to the Swedes as they marched to the attack. Wallenstein had seized the highway in front of his position, had deepened the trenches that ran along its course, and lined them with a strong body of musketeers, supported by a battery of seven heavy guns in position on a slight eminence in the rear, and had secured a flanking fire by occupying a hill in front of Lützen, and at the right of his line. Three windmills that stood on the crest of this eminence were occupied by his troops. In front of these was a battery of fourteen guns, and several enclosed gardens in the immediate vicinity were strongly garrisoned, and their walls loop-holed for musketry. Pappenheim had taken about 20,000 men with him, but it is more difficult to estimate the numbers of those who remained to contest the field. The totals given by different authors vary in amount between 12,000 and 30,000. From a comparison of authorities, and the appearance of Wallenstein's line of battle as shown on the plan, I should


BATTLE OF LÜTZEN 6th Novr 1632.
Knyphausen
Henderson
Stalhanske
THE KING
Brahe
Bernard of Saxe Weimar
LÜTZEN
Road from Wesentitz to Leipsic
7 Heavy Guns
Field Artillery 14 Guns
Wallenstein
Holk (or Goetz)
Coloredo
Imperialists
Swedes

J.R.Jobbins.

be inclined to think that he had about 25,000 men under his immediate command at the commencement of the engagement, while the king's forces could scarcely have amounted to more than 20,000.

The Swedes were drawn up in line of battle long before sunrise, but, so dense was the fog that brooded over the plain, that Gustavus, to whom every moment, in consequence of the proximity of Pappenheim, was of incalculable importance, was long compelled to delay the attack. At length, about ten o'clock, a few straggling rays penetrated the gloom, and were thrown back from the polished arms and glittering pikes of the Imperial army. The king at once gave the signal of battle, and placed himself, as in many a bygone day of glory, at the head of the right wing.

The whole first line of the Swedes now rushed to the attack. Far to the left Duke Bernhard scaled the hills in front of his position, carried the 14-gun battery, drove the defenders out of their walled enclosures, and penetrated to the very foot of the windmills. But at this point, attacked in flank and rear by the cavalry of Isolani, who had crept round under the friendly veil of the fog that once more enveloped the field in its vaporous wreaths, he was forced to retire step by step down the incline, till he reached the plain, where he halted to form his ranks afresh for a second and more desperate assault.

In the centre the Swedes, in spite of a galling fire of musketry, advancing with their accustomed impetuosity, cleared the ditches in front of their defenders, and still pressing forward, crossed the high road, captured the first battery, encountered and routed the two nearest brigades of infantry, and poured on in apparently irresistible strength through a yawning gap in the Austrian line. The battle seemed all but won in the first shock of arms, when Wallenstein, hurrying forward with a third brigade, rushed upon the Swedes, disorganized and isolated by the rapidity of their success. His fresh troops gradually drove their opponents past the battery, the high road, and the ditches, and almost to the position they had held an hour before. A thousand men had fallen, and not an inch of ground was gained.

The king at the head of the right wing fell on the enemy's cavalry directly in his front. He scattered the Croats and light troops like chaff before the wind, and after a sterner and more glorious contest drove Piccolomini's heavy cavalry off the field. At this moment he was informed of the disasters that had befallen his centre and left. Entrusting the command of the right wing to Gustavus Horn, and ordering Colonel Steinbok's Smäland regiment of cavalry to follow at full speed, he galloped towards the point of danger; unfortunately, in consequence of the density of the fog, and his own shortness of sight, gradually getting closer and closer to the enemy. An Imperialist corporal, who had observed the respectful manner in which every one had made way for the king as he passed along in front of his line, now ordered one of the musketeers beside him to take aim at the tall officer on the white horse, as it was evident he must be a man of distinction. The musketeer obeyed, and his shot broke the king's left arm. At this moment a squadron of Swedish cavalry, sent to cover their leader, rode up and received him into their ranks. A cry of terror rose among them at the sight of his blood. He endeavoured to reassure his companions at the first, but in a few moments, feeling the pain of the

wound intolerable, he requested the Duke of Saxe Lauenburg to lead him out of the battle. He had proceeded but a few paces when a second shot struck him in the back. "Brother," said he, "I have had enough; look to your own life;" and dropping the reins, fell heavily from his horse. Scarcely had he touched the ground when a charge of Croatian cavalry swept up to the spot. "Who are you?" cried out the foremost, struck by the dignity of his aspect, and the sight of the insignia of his rank. "I am the King of Sweden," he answered, boldly and resolutely, though with dying voice. The Croats rushed on immediately, not to save but to slay, and continued to heap wound on wound long after the noble spirit had quitted its frail tenement of clay. The body was now stripped naked, and would have been carried off but for the accidental arrival of a body of Swedish cavalry, who dashed in among the plunderers, and in their charge passed unwittingly over the spot where lay the remains of their heroic king.

It is beyond my purpose to enter into further details of the great battle of Lützen, the fiercest fight that ever raged on European soil. Suffice it to say that the Swedes, under the able conduct of Duke Bernhard of Saxe Weimar, annihilated in succession the army of Wallenstein, the cavalry of Pappenheim, and the infantry that followed his march from Halle. It was said that of the 45,000 Imperialists who at different times took part in the action scarce one escaped without a wound. Of 18,000 Swedes, Scots, and Germans who had stood in battle array that morning, but 9,000 gathered round the bivouac fires at night. The search for the body of the king was long continued in vain, but it was at length drawn forth, scarcely recognisable indeed but for its heroic proportions, pierced as it was by countless wounds, and torn and disfigured by the hoofprints of the masses of cavalry that had swept backwards and forwards over the spot throughout that long and bloody day. Brought to Erfurt, it was there consigned to the tears and embraces of the widowed queen. For eighteen months afterwards the coffin lay in her chamber. Every ray of light was excluded, and Maria Eleonora, dressed in deep black, sat day and night by the bier, as some said believing that a miracle would yet be wrought, and her noble spouse rise again to life from his narrow home. Twenty years later the sepulchre of the Vasas was opened again, that her worn and wasted frame might be laid by the side of him whom she had loved with a love that was stronger than death.

I have thus endeavoured to trace the military career of one of the greatest of modern generals during the two years that were the most glorious—but, alas, the last!—of his heroic life. The test of life is success. Misfortune may bear back for a while, but can never permanently check the onward course of genius. The victor of twenty campaigns has chained success to his standards, not by favour of fortune, but by superiority of intellect. The general, who, at the head of but a few thousand men, supported only by the resources of a poor and barren land, and deserted by the allies on whose assistance he had based his firmest hopes, yet in two short years bends beneath his sway lands ten times superior to his own in population, wealth, and military strength, who defeats every competitor in the field of war, who is the originator of a system of discipline that the experience of two centuries has confirmed, needs not the

feeble panegyric that these lips could bestow. Had his life been prolonged, what a wondrous page in history might have been bright with the records of his fame. All Europe in another year would have trembled before his frown. Monarchs at this day would have dated the origins of their lines from the campaigns of Gustavus of Sweden.

Yet, happy as he was in his life, happy in the love of two great countries, the cold kiss of the Angel of Death was perhaps not the least of the blessings showered on his brief but glorious career. Bright and straight and laurel-strewn was the path that the hero's feet had pressed, but the broad and flowery way that lay beyond stretched with many a deceptive bend towards the treacherous precipice to which the fair fiend Ambition was striving to allure him with silver voice and witching smile. In mercy Death strode between the enchantress and her destined prey, and saved him from a struggle in which even his resolute spirit might have failed.

In the thirty-eighth year of his life, in the pride of his manhood and the zenith of his fame, died Gustavus Adolphus, the Lion of the North. Old men have gone to their graves with the bitterness of a wasted life, of talents lost, of opportunities neglected. He met his doom in the summer of his days with yet the purpose of his life achieved. It was his hand that had stayed the onward march of a despotism that had threatened to involve the world in one vast monotony of slavery, his hand that hewed down the Medusa whose weird gaze was petrifying the life-blood of the young nations of Christendom. His epitaph is written in deeds. Of all men that ever lived he may most emphatically be styled the liberator of Europe, of this country as well as any other. Who can say what might have been our fate if Austria, unchecked in her fierce and daring attempt on the independence of mankind, had flung in the sword of a Tilly, a Pappenheim, or a Wallenstein, at the time when the cause of our constitutional liberties was trembling in the balance.

The answer comes, comes from the fair and fertile lands where the stately city of Venice fades on the bosom of the sea, that she wooed with nuptial rite, with wreath and ring, with music and with song, in the days of her glowing youth; from the wide fields whence the Galician views with tears the mighty dome that, upreared by pious hands of old, still shades the sacred spot where moulder into dust the relics of a hundred kings of the high-souled races of Jagellon and Piast; from the boundless plains where the mighty of the desert mustered myriad and myriad strong, when the sword of the War God flashed in the summer's sun, and earth trembled to her centre beneath the conquering tread of the Scourge of God. And if no English voice mixes in the dirge of nations, widowed of the glories of the past and robbed of the future's hopes, thanks to the good swords that braved the tiger in his lair and shore him of his demon's strength; thanks to the god-like chief who won Truth her triumph and Liberty her existence with his own heart's blood; to the statesman, patriot, and hero, without fear and without reproach, to Gustavus Adolphus, the Lion of the North!

Friday, February 28, 1862.

MAJOR-GENERAL J. E. PORTLOCK, R.E. in the Chair.

THE IMPORTANCE OF A KNOWLEDGE OF GEOLOGY TO MILITARY MEN.

By F. W. HUTTON, Esq. 23d Royal Welsh Fusiliers, F.G.S.

THERE is in the army a wide-spread though undefined opinion that a knowledge of geology is useful to soldiers; but how, and in what way, it is useful, many officers are, I believe, quite ignorant; and seem to be much in the same predicament as some cadets belonging to the Royal Military Academy at Woolwich, who were asked the question at their examination two or three years ago: some answered that it was a nice amusement, and kept them away from the billiard table; others said that it was a fashionable science, and therefore all officers ought to have some acquaintance with it, so as to be able to talk about it in society; while others candidly confessed that they thought it was of no use at all.

It is to try to rescue Geology from this false position, and to show that the opinion of its usefulness is, in reality, well founded, that I venture to point out to you this afternoon some of its practical applications to military science.

I do not claim any originality for the remarks that I am going to make; they are simply collected from various sources, and I wish particularly to acknowledge the obligations that I am under to Sir C. Lyell's Principles of Geology, to Sir H. De la Beche's How to Observe, to Mrs. Somerville's Physical Geography, and to my friends Professor Ramsay and Mr. Godwin-Austen.

The advantages to be derived from a study of the physical sciences have been summed up by Sir J. Herschel as follows :

I. In showing us how to avoid attempting impossibilities.

II. In securing us from important mistakes in attempting what is, in itself, possible, by means either inadequate, or actually opposed to the end in view.

III. In enabling us to accomplish our ends in the easiest, shortest, most economical, and most effectual manner.

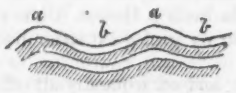
IV. In inducing us to attempt, and enabling us to accomplish, objects which, but for such knowledge, we should never have thought of undertaking.

My object is to show, in a general way, how Geology, the branch of physical science that investigates the structure of the globe on which we live, and the causes which influence that structure, bears upon these points; and why it is, to military men, by far the most important of all the sciences, and therefore the one to which their attention should be principally directed.

It is not necessary here to describe in detail, much less attempt to prove, the principal facts that have been arrived at by a study of our globe: I shall therefore take it for granted that the surface, or crust, as it is sometimes called, of the earth is composed of rocks, not scattered in confused masses over the whole world, but arranged in strata of sandstones, limestones, and clays, superposed upon one another in various orders; that these rocks were originally formed under water in a nearly horizontal position, then consolidated by heat, pressure, or by chemical agencies; and, after perhaps many oscillations, have since been raised into their present places by forces acting from below: that, in these processes, they have often been bent, broken, and pierced by other rocks, such as granite, greenstone, &c., which were at that time in a liquid state, and have since become hard: that the whole have undergone denudation * to an enormous extent, valleys having been scooped out and broken surfaces levelled; and that the present configurations of mountains, continents, islands, &c. are due to these causes.

If then we take for granted that the shape and direction of hills and valleys depend upon causes which it is the province of Geology to investigate, it is evident that the physical geography of a country cannot be properly understood until the geologist has shown how the mountains have been formed, and which are the principal axes of upheaval; for it is not always the most elevated ridges that are axes of upheaval; Ben Nevis and Snowdon, for example, the highest mountains in Scotland and Wales, are synclinals;† and, as the *military geography* of a country depends

* The wearing away of rocks by moving water. To show to what an enormous extent denudation has taken place, I may mention that Professor Ramsay has shown that the missing beds removed from the summit of the Mendip Hills must have been nearly a mile in thickness; and he has pointed out considerable areas in South Wales where a series of primary strata of not less than 11,000 feet, or more than two miles, in thickness have been stripped off.



† When strata are bent into undulations, a curve with its convex side upwards (*a*) is called an *anticlinal;* and the line running along the top of the curve, at right angles to the plane of the paper, and from which the strata slope, or *dip*, on each side, is called an *anticlinal axis*. A curve with its convex side downwards (*b*) is called a *synclinal;* and the line towards which the beds dip is called a *synclinal axis*. It is evident that a synclinal cannot have been an axis of upheaval; but it may form a mountain, as in the annexed figure.

entirely upon its *physical geography*, it follows that an acquaintance with Geology is necessary to be able to study it thoroughly; for, although a certain amount of knowledge can be obtained from maps and books, yet it is only by a knowledge of its geological structure and composition that we are enabled to form any correct idea of a country without actual inspection.

To explain: Unlike plants and animals, the same kinds of rocks are distributed all over the earth, and assume the same shapes wherever they may be; so that the knowledge obtained by studying them in one place is available for any other. Different kinds of rocks also form different kinds of mountains: some present high perpendicular cliffs with rocky inaccessible summits, bare of vegetation; others soft grass-grown slopes, with rounded outlines. Granite appears, when forming the tops of mountain ranges, in pyramids or wedges; when forming the main rock of a country, in truncated and shapeless masses. Gneiss and the crystalline schists occur in high sharp needle-shaped peaks with steep escarpments and deeply serrated ridges. Slaty rocks make a smooth and undulating country, but when slate is interstratified with hard schists it is rugged and precipitous. Trap and basalt often form perpendicular walls. The slopes of the unaltered sedimentary rocks are generally more gentle and rounded; but dolomite frequently appears in high abrupt peaks. Insulated mountains are generally of volcanic origin. That side of mountain chains nearest the sea is nearly always more precipitous than the opposite one—the south side of the Alps for instance, and the east side of the Alleghanies. In ranges that form the boundaries of lakes, or extensive valleys, through which great rivers flow, the mountains nearest to the river or lake have generally the steepest slopes. Rivers in a mountainous country are deep and rapid, usually with high banks, and are in general so much embarrassed by large stones as to be difficult for cavalry and impassable for carriages, while in plains they are sluggish, very tortuous in their course, often with low marshy banks, and are generally full of islands. When the strata, of which the country is composed, are arranged horizontally, large level plains and plateaux frequently occur, but this is seldom the case if they are inclined.

Again, as the nature of the country in which an army is to operate must always be taken into consideration, not only in all our own arrangements and combinations, but also with reference to the probable manœuvres of the enemy, it follows that its geological structure and composition must necessarily influence any movement, quartering, or matters connected with the subsistence of troops; and consequently all officers charged with any of these arrangements should possess a competent knowledge of that science. For, instance, in choosing ground for an encampment, especially if for any length of time, when the drainage would become of importance, geology lends its aid in many ways. It shows how to avoid wet clays, and where to find dry sand or limestone. In case of a scarcity of wood for fuel it points out where peat will most probably be found; occasionally even it might discover a bed of coal.

Peat is formed in stagnant basins from the rushes, sedges, mosses, &c. that grow in them; as these die they gradually fill up the hollow, and form a bog of loose spongy vegetable matter; the remains of the plants,

immersed in water, soon decay, become brown and soft, and are eventually converted into a black soap-like mass, called peat or turf. Small deposits of peat are found in almost every country: in mountainous ones, which are often nearly destitute of trees, the hollows are frequently filled with it; the constant assemblage of clouds upon the mountains favouring their growth by a gradual but incessant supply of moisture. These bogs are of course never extensive, and seldom exceed six feet in depth; still they might be of great use. Peat is often covered by a layer of sand or vegetable mould, and would not then perhaps be detected unless expressly sought for; it is always found in horizontal beds. It is prepared in Ireland by simply removing the surface soil, cutting it into bricks with a spade, and piling them loosely together to dry: when too wet to be cut, it can be moulded by pressure into bricks and then dried. The value of peat is in proportion to its dryness, density, and firmness; the longer it is kept and allowed to dry the more it will improve: even when well dried it contains about one-tenth of its weight of water.

During the war in the Crimea the allied forces were partly supplied with coal from Eregli (Heraclea), on the south coast of the Black Sea. In 1855 the English government were advised that this supply might be increased by following the direction of the beds across Bithynia, and a Mr. Poole was sent out to inspect and report; but he seems to have been guided by information obtained from the natives, and in every instance to have gone in search of superficial peat, of which abundance is to be found about the great lakes. What he ought to have done is this—starting from the coast section on the Black Sea, he should have made himself acquainted with the aspect and dimensions of the carboniferous beds, and followed them along their line of outcrop;* this he could have done, as there are no overlying formations, and he undoubtedly would have come on some spot where the coal-seams were in a convenient position for working from the surface, for they are very numerous. In this case a better geological survey would have been a great saving, for in 1855 coal, delivered in the Black Sea, cost the government 6*l.* a ton.

With respect to the water supply of camps, the geologist is often able to decide whether it is possible to obtain water by sinking wells, or whether they would have to be made so deep, before a supply could be obtained, as to be useless. Water is constantly passing upwards in the form of vapour from the surface of the land and sea; it is condensed into clouds by the coldness of the higher regions of the air, and falls to the earth again in the form of rain, hail, or snow; the greater part of it then descends into the earth, and is accumulated in the various rocks, from which it is discharged in the shape of springs. All rocks contain more or less water, but while in some it is kept there by mechanical means alone, and can therefore be easily obtained from it, in others it is held by adhesion, or capillary action, so that simple drainage will not extract it.

The two things in the structure of the earth's crust that principally influence the collecting of water, are the alternation of porous beds of sand and limestone with impervious ones of clay, and the faults and dislocations of the strata. When a hill is formed of a porous rock at the top, resting

* A stratum is said to outcrop when it comes to the surface.

entirely upon its *physical geography*, it follows that an acquaintance with Geology is necessary to be able to study it thoroughly; for, although a certain amount of knowledge can be obtained from maps and books, yet it is only by a knowledge of its geological structure and composition that we are enabled to form any correct idea of a country without actual inspection.

To explain: Unlike plants and animals, the same kinds of rocks are distributed all over the earth, and assume the same shapes wherever they may be; so that the knowledge obtained by studying them in one place is available for any other. Different kinds of rocks also form different kinds of mountains: some present high perpendicular cliffs with rocky inaccessible summits, bare of vegetation; others soft grass-grown slopes, with rounded outlines. Granite appears, when forming the tops of mountain ranges, in pyramids or wedges; when forming the main rock of a country, in truncated and shapeless masses. Gneiss and the crystalline schists occur in high sharp needle-shaped peaks with steep escarpments and deeply serrated ridges. Slaty rocks make a smooth and undulating country, but when slate is interstratified with hard schists it is rugged and precipitous. Trap and basalt often form perpendicular walls. The slopes of the unaltered sedimentary rocks are generally more gentle and rounded; but dolomite frequently appears in high abrupt peaks. Insulated mountains are generally of volcanic origin. That side of mountain chains nearest the sea is nearly always more precipitous than the opposite one—the south side of the Alps for instance, and the east side of the Alleghanies. In ranges that form the boundaries of lakes, or extensive valleys, through which great rivers flow, the mountains nearest to the river or lake have generally the steepest slopes. Rivers in a mountainous country are deep and rapid, usually with high banks, and are in general so much embarrassed by large stones as to be difficult for cavalry and impassable for carriages, while in plains they are sluggish, very tortuous in their course, often with low marshy banks, and are generally full of islands. When the strata, of which the country is composed, are arranged horizontally, large level plains and plateaux frequently occur, but this is seldom the case if they are inclined.

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on a bed of clay below, the water sinks through the upper stratum to the impervious one, and then, not being able to penetrate further, runs out in springs. The reasons why it forms distinct springs, and not a continuous ooze along the line of outcrop, are the frequency of fissures in the porous rock, and the inequalities of the surface of the subjacent clay.

There are two different kinds of springs which are caused by faults,* one where the water in a porous stratum is simply intercepted by the fault and diverted to the surface, the other where the spring is maintained by the water being forced up from below, as in Artesian wells.

To estimate approximately the quantity of water received each year in the rocks of any given district, we must know the mean annual rainfall at the place, the amount of evaporation, and the amount discharged from the surface by streams; this last has been calculated by M. Arago, for the valley of the Seine, to be about one-third of the whole rainfall. It is impossible to say what the amount of evaporation at any particular place may be, for it depends on the roughness of the surface exposed, and on the wind blowing over that surface, as well as on the density, temperature, and dryness of the air. The average rainfall at London is about 24½ inches per annum, and it is considered a heavy rain if an inch falls in 24 hours. It may also be useful to remember that an inch of rain over an acre is about 100 tons, or 22,500 gallons, of water. Besides these, we must also know the absorbent power of the rocks, their dip and thickness, the faults and fissures in them, and the nature of the underlying beds.

The simplest conditions under which water is collected in the earth, are when a bed of gravel or sand rests upon a substratum of clay. Owing to the porous nature of these rocks, and the consequent rapidity with which they are drained, the supply of water from the shallow wells sunk in a bed of this description is very variable, and is greatly influenced by the weather; but it depends upon the area that is exposed to the rain at a higher level, and to the position and magnitude of the springs that flow from it; and, as an assistance for calculating what a well might be expected to produce, I may mention that loose sand or gravel will absorb about one-third of its volume of water, that is, about two gallons per cubic foot, and will part with nearly the whole of it by drainage.

The facility with which water can percolate loose and gravelly soils is very great. The Thames saturates the gravel through which it flows, between London and Richmond, to a distance of several hundred feet each time that the tide rises, which is drained again as it falls; so that the wells in this tract regularly ebb and flow. Cess-pools, &c. should therefore never be placed near wells of this kind, as the impurities would filter through from one to the other and render the water unwholesome.

It appears by the experiments of Professor Ansted that a moderately hard sandstone will absorb from four to five pints per cubic foot, and will part with most of it; and it is considered that, under favourable circumstances, a deep well in sandstone will yield daily, to hard pumping, about a million of gallons.

Limestone, such as the Northamptonshire oolite, will absorb from 7 to 8

* When the strata on one side of a fissure have been moved upwards or downwards more than on the other side it is called a fault. There is a fault at (*c*) in fig. 2.

Fig. 1

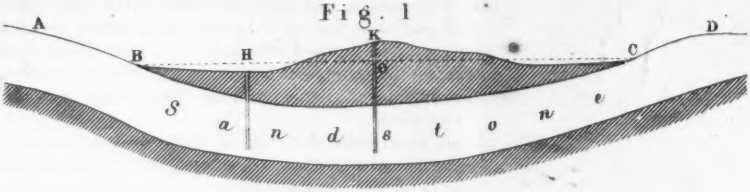
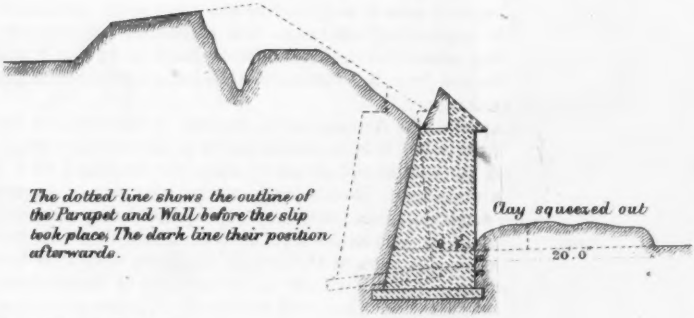


Fig. 3.


The dotted line shows the outline of the Parapet and Wall before the slip took place, The dark line their position afterwards.
Clay squeezed out
20.0

Bramhope Hills

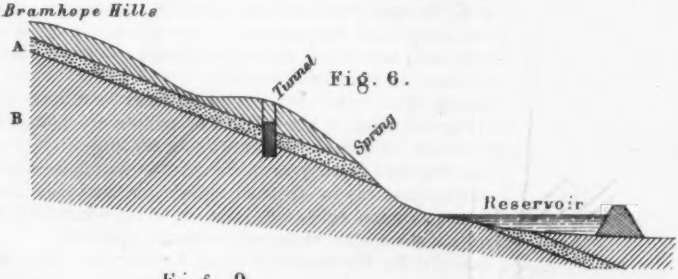
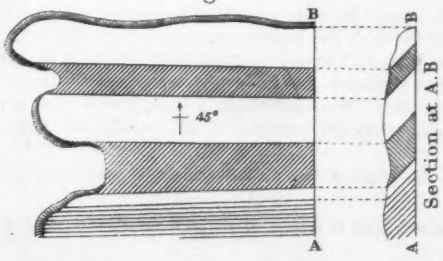


Fig. 6.

Fig. 9.



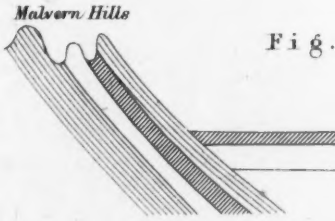


Fig.

Fig. 2

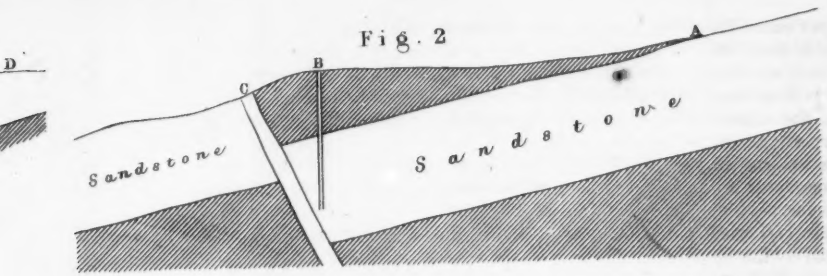


Fig. 4.

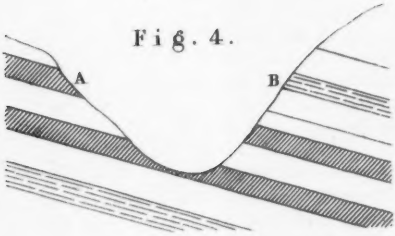


Fig. 5.

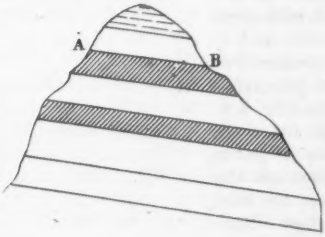


Fig. 7.

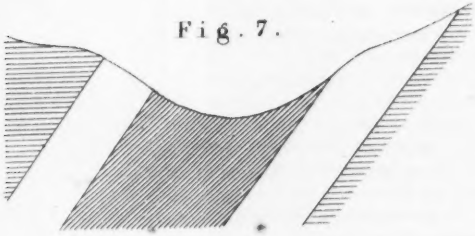


Fig. 8.

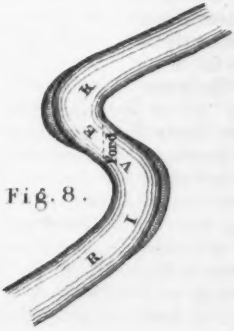
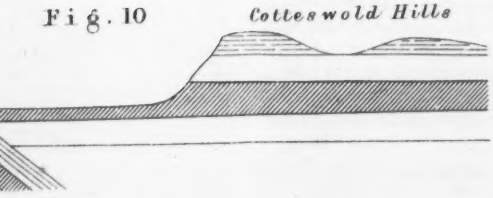


Fig. 10



pints per cubic foot; while chalk, like loose sand, will absorb two gallons per cubic foot, but will part with none of it by drainage; a well, therefore, sunk in it would never contain water if the chalk were perfectly compact; but it is found in practice that almost all rocks are full of cracks through which the water flows: this is the cause why wells sunk in a chalk country are generally so deep.

It is evident that all these wells, deriving, as they do, their water from drainage, must necessarily exhaust the surrounding rocks; two of them should therefore never be placed close together.

There is, however, another class of wells called Artesian, which, being supplied by the hydraulic pressure of large masses of water in the interior of the earth, may be sunk in close proximity. As these wells are of great depth, and take in consequence a long time to sink, they ought perhaps to be spoken of as an engineering operation, rather than having any connection with choosing ground for an encampment; but I think that it will be clearer, and take less time, if I introduce them here, together with the other means of water supply.

The principle upon which Artesian wells depend is explained in the diagram (fig. 1.) Let A B C D be a section across a basin-shaped valley, and let the shaded parts represent strata of clay, the unshaded part a stratum of porous sandstone. Rain, falling on the hills A and D, will soak through the sandstone, and, being kept up by the lower clay, will saturate the whole bed as high as the level of B C: it will then run over in springs. If now a well is sunk at H, through the upper stratum of clay into the sandstone, the water will rise in it, by the laws of hydrostatics, and, if it is on a lower level than B C, will overflow. If, however, it is on a higher level, as at K, the water will not rise above O. Of course, if B and C are not on the same level, the water will only rise in the wells as high as the lower of the two; and also, if the porous stratum is not saturated to the level of H, the water in it will not overflow.

In 1838 the total supply of water obtained by Artesian wells from the chalk near London was estimated at six millions of gallons a day, and in 1851 at nearly double that amount, the increase being accompanied by an average fall of no less than two feet a year in the level to which the water rose. The water stood commonly in 1822 at high-water mark, and had sunk in 1851 to 45, and in some wells to 65, feet below high-water mark. This fact shows the limited capacity of the subterranean reservoir.

It is absolutely essential for the formation of an Artesian well that the porous bed should lie between two impervious ones; but it is not always necessary that the strata should have a basin shape. Sometimes an impervious dyke * may cut through the porous stratum and so hold up the water; as in the diagram (fig. 2), where the water, stopped by the dyke C, would rise in the well B to the level of A. In this case it will be noticed that, owing to the fault at C, the water would overflow in the well, although its level is higher than the junction of the porous bed and the clay at C.

Artesian wells are of the greatest use in low and level districts, where

* When a mass of igneous rock such as granite or trap cuts through the strata it is called a dyke.

water cannot be obtained from superficial springs, or by ordinary wells of moderate depth; for it must be borne in mind that the hills A and D (fig. 1) may be at great distances apart. The chalk hills on either side London, for example, are some 40 miles distant from one another.

Artesian wells have, I believe, been successfully employed by the French military engineers in Algeria.

The principal causes of failure in sinking these wells are the numerous fissures and faults which abound in some rocks; the unexpected thinning-out,* and change in lithological character, of the rocks under ground, and the deep ravines and valleys by which many countries are traversed; for, where these lines of natural drainage exist, there only remains a small quantity of water to escape by artificial openings.

In sinking wells care must be taken, when the impermeable bed supporting the water is thin, not to cut through it; for by so doing the water would be let out into the rock beneath, if that should happen to be porous, as has very often occurred.

In order then to select properly the ground for an army to encamp upon, the sanitary officer attached to the Quarter-Master-General's department with an army in the field ought to have a good knowledge of Geology: in fact it seems likely that the healthiness or unhealthiness of a district depends chiefly upon its geological structure and composition.

Dr. Buckland, in the first chapter of his Bridgewater Treatise, says that "if a stranger, landing at the extremity of England, were to traverse the whole of Cornwall and the north of Devonshire, and crossing to St. David's, should make the tour of all North Wales, and passing thence through Cumberland, by the Isle of Man, to the south-western shore of Scotland, should proceed either through the hilly regions of the border counties, or along the Grampians, to the German Ocean, he would conclude, from such a journey of many hundred miles, that Britain was a thinly-peopled sterile region, whose principal inhabitants were miners and mountaineers.

"Another foreigner, arriving on the coast of Devon, and crossing the Midland counties, from the mouth of the Exe to that of the Tyne, would find a continued succession of fertile hills and valleys, thickly overspread with towns and cities, and in many parts crowded with a manufacturing population, whose industry is maintained by the coal with which the strata of these districts are abundantly interspersed.

"A third foreigner might travel from the coast of Dorset to the coast of Yorkshire, over elevated plains of oolitic limestone or of chalk, without a single mountain, or mine, or coal-pit, or any important manufactory, and occupied by a population almost exclusively agricultural.

"These dissimilar conditions of three great divisions of our country result from differences in the geological structure through which our three travellers have been conducted. The first will have seen only those north-western portions of Britain that are composed of rocks belonging to the primary and transition series (the Metamorphic, Cambrian, Silurian, and Devonian, of modern geologists); the second will have traversed those fertile portions of the new-red-sandstone formation which are made up of the detritus of more ancient rocks, and have beneath, and near them, in-

* When a stratum becomes gradually less and less in thickness in any direction until it finally disappears it is said to thin out.

estimable treasures of mineral coal; the third will have confined his route to wolds of limestone and downs of chalk, which are best adapted for sheep-walks and the production of corn.

"Hence it appears that the numerical amount of our population, their varied occupations, and the fundamental sources of their industry and wealth, depend, in a great degree, upon the geological character of the strata upon which they live. Their physical condition also, as indicated by the duration of life and health, depending on the more or less salubrious nature of their employments and their moral condition, as far as it is connected with these employments, are directly affected by the geological causes in which their various occupations originate."

From this we learn that even a general knowledge of the geology of a country would enable the commissariat officer to judge whether it is likely to be fertile or barren, and would point out to him where to look for corn, and where for forage, where for manufactures, and where for beasts of burden.

To the military engineer a knowledge of geology is invaluable, as has indeed been long recognised. In choosing building-stone, especially in countries not well known, he should examine those exposed in sections, ascertaining whether the sections have been caused by recent landslips, or if they have been in existence for ages. He must then examine how the stone has weathered, observing carefully if the changes have been caused by the chemical or the mechanical action of the atmosphere; that is, he should observe whether any of its component parts have united chemically with those of the air, or the substances contained in it, or whether it has been worn, and the edges rounded off, by the friction of water, or by the expansion of ice formed in the interstices of the stone. Care should be taken to note the structure of the stone, ascertaining if it is homogeneous, like compact limestone, or if it is composed of substances which, when exposed to the same causes of decomposition, resist them unequally: such as granite and conglomerate. Many stones are soft and easily worked when first taken from the quarry, and afterwards, on exposure to the air, become hard, owing to the evaporation of what is called the quarry-water contained in them. Some of these readily absorb moisture again, while others do not: hence the latter should be preferred. Some sandstones are always damp, owing to the deliquescent salts contained in them; this can generally be cured by washing them with sulphuric acid, which decomposes the salts.

For building breakwaters the specific gravity of the stone is an important consideration; as the greater the weight the greater is the resistance offered to removal. In constructing piers, bridges, &c. materials which are good for one part, may not be so for another: for instance, a porous sandstone, which may be advantageously employed if always kept under water, is liable to decomposition when exposed to the atmosphere, particularly in those situations that are kept alternately wet and dry by the rise and fall of the tide. Much information on this head can be obtained by studying the condition of rocks on the banks of rivers, and on the sea-shore.*

* Brard's method of obtaining the resisting power of stones to frost is a very good one. Boil the specimens in a saturated solution of sulphate of soda, and then hang them up in

Having settled which stone to employ, a knowledge of its dip will enable the engineer to trace it to other points, and thus open quarries in places where, but for the help of Geology, he would never have thought of looking.

A knowledge of Geology will also assist him in finding limestone for cement, sand for mortar, slates for roofing, &c. A case that occurred a few years ago at Portsmouth illustrates this. Cement was wanted in the construction of the new forts. This cement was made from nodules of calcareous clay called *septaria*, which come originally out of the London clay; but at Harwich, from whence the principal supply is obtained, they have been washed out of the clay and are dredged up in large quantities from the sea. Now the forts at Portsmouth are built on the same London clay in which these septaria are found; but, in ignorance of their nature, they were actually broken up to mend the roads, while others were brought by rail to make cement.

Geology will also help the engineer to judge if the rock on which he means to build will afford him a secure foundation. During the construction of Fort Elson at Portsmouth part of the escarp wall subsided, and slipped forwards; the clay being squeezed up in front of it, as is shown in the diagram (fig. 3). This was owing to its having been built upon the London clay. The treacherous nature of this clay, and its great tendency to slip, and be squeezed out when any weight is put upon it, is well known to geologists, and, I may add, to railway directors and engineers, the cuttings in it being always a source of trouble and expense. When the South Eastern Railway was first made, the slips in the cuttings through this formation were so great as occasionally to stop up the line; and even now the vibration produced by the passage of trains often causes slides to take place, or loosens portions in such a way that the next shower brings them down. If then the weight alone of the fort, and that even before it was finished, was sufficient to make the foundations give way, what might we expect to have happened after a day's heavy firing from it, and after a battering from the enemy's guns? Precautions have now been taken against these accidents; but, if the knowledge of geologists on the subject had been used, the expense of pulling down the sunken portion of the wall, and repairing it, would have been saved.

In constructing canals a knowledge of the geological structure of the country will often be a guide to the engineer as to the proper position of the summit levels, where he need not fear the want of water; and how to avoid porous strata, which would oblige him to go to the expense of rendering the canal-bed water-tight. It must be remembered that a knowledge of the rocks on the surface will not always give a knowledge of those that may be cut into along the line of a canal. A thin stratum of clay may exist on the surface, and rest upon a porous sandstone; and, in following the levels, the former may be cut through, and the canal-bed be based upon the sand.

In making roads the engineer will also find a knowledge of Geology of

a dry air. The salt in crystallizing will pretty accurately represent the force of water in freezing, and will chip off portions of the stone. These fragments being collected and weighed will represent numerically the resisting powers of the stones, the smallest of course being the best.

great use in showing him where to carry them so as to avoid a soft clayey bottom, which is always difficult to drain and render firm; where to find a hard and porous rock, easily kept in good order; how to avoid, or take precautions against, the springs that so often occur in the stratified rocks; and how to prevent slips taking place in his cuttings.

For example; Suppose that A B (fig. 4) is a section of a valley, along either side of which it is required to carry a road, and let the cross lines represent the dip of the strata that form it. Now to the non-geological engineer one side might appear equally as good as the other, but the geologist would at once see, that, if the road is made at A, it would most likely be wet, because the water would run down through the divisions between the strata; that slips would take place if the dip is greater than the angle of repose; and that the cutting would require a slope at least equal to the dip: but, if the road is made at B, it would be dry, there would be no fear of slips, and the cutting might be made nearly perpendicular. If, instead of a valley, the road had to be carried along either side of a hill with the same dip (fig. 5), the case would be exactly the reverse, and the road should be made at A instead of B.

In 1843 the Leeds and Thirsk Railway Company projected a tunnel through the Bramhope Hills, from which issue the springs and streams that partly supply the Eccup Reservoir belonging to the Leeds Waterworks Company. In 1845 Mr. Curley, a civil engineer and also a geologist, was instructed by the Water Company to make a model of the district, for the purpose of illustrating the geological and engineering evidence required in opposing the railway bill before the Committees of both Houses of Parliament, and by which they succeeded in getting a clause introduced for compensating the Water Company for any loss of water they should sustain through the railway works. This diagram (fig. 6) will explain the facts of the case. The strata are part of the millstone-grit formation, A is a porous bed, and B is impervious to water. The rain, therefore, falling on the hills passes through until it reaches B, along the top of which it flows, and issues at the outcrop in springs which supply the reservoir. The porous bed being cut through by the railway works, as is shown in the diagram, the water was intercepted and carried into the tunnel, drying up the springs, as had been predicted by Mr. Curley. The pumping of the water alone out of the tunnel during its construction cost the contractor nearly as much as all the other works connected with it put together. Thus the Water Company, by employing the aid of geology, was saved from a severe loss, whilst both the contractor for the tunnel and the Railway Company, by ignoring that aid, incurred heavy expenses.

The inclinations at which cuttings and embankments can be safely made entirely depend upon the nature of the soil; clays generally requiring a slope of about 1 in 3, chalk marl 1 in 1, and sandstone or limestone 1 in 1. If strata of sandstone alternate with clays or marls, the inclination at which the slopes will stand, depends upon the dip. If the road runs along the line of strike * large masses of stone will become

* The line of strike is a line drawn at right angles to the dip of a stratum, and is the line along which it would come to the surface on level ground. Thus, if a bed dips north its strike is east and west.

detached and slip down over the smooth surface of the clay, even when the slopes are as much as 1 in 4 ; but if the road runs at right angles to the strike the slopes may be made 1 in 1·5. If the strata are horizontal, and the beds of marl are faced with stone, the slopes will stand at 4 in 1. In all cases where beds of sand or gravel are intermixed with clay drains should be cut along the top, and even in the sides of the cuttings, for if this precaution be not taken water will find its way into the gravel, and will by its pressure force the body of clay down before it, and slips will take place. All this evidently applies to the slopes of the ditches in field-works as much as to cuttings for roads.

On investing a fortress, a knowledge of Geology may often show the engineer where to find ground favourable for making trenches, and enable him to judge if it is likely to continue the same as far as the glacis; and I need hardly say how useful it might be in mining, although a military mine is never sunk very deep.

In blasting rocks much labour is saved by taking advantage of the joints and other divisions of the strata. To do this may seem very simple, and hardly to require much acquaintance with Geology, but it often takes an experienced geologist to distinguish between joints, cleavage, and planes of stratification.*

But it is perhaps, after all, to the staff-officer making a reconnaissance that Geology affords the greatest assistance, not only in sketching the country, but in supplying him with an immense amount of information about the position of villages, the supply of water, the character of roads, rivers, marshes, fords, &c.

With regard to surveying, its chief value is in a mountainous country. Mountains are generally found in groups intersected by valleys in every direction. These groups are often arranged in a series of parallel chains, the highest and most rugged of which occupy the centre; the lateral ones are constantly of less elevation and less bold in proportion to their distance from the central mass, until at last those most remote sink down into gentle undulations. To understand mountains properly we must consider the formation of valleys. Valleys, geologically speaking, may be classed under two heads, viz., valleys of elevation, and valleys of denudation. Valleys of elevation are formed either by the upheaval of the strata on each side of them, or by the sinking of the ground, leaving the adjacent rocks unmoved, or, as is most commonly the case, by lateral pressure, the strata in all cases being bent into a trough-shaped form. Valleys of this kind are broad, and at some distance from one another, forming a series of parallel ridges and furrows, the furrows being synclinal and the ridges anticlinal axes. Valleys of denudation are formed by the erosive power of running water. They are by far the most common, and their form is infinitely varied. This depends, however, on the hardness and direction of the strata. The main valleys generally run either in the direction of, or at right angles to, the strike, and the

* A plane of stratification is the line of division between two distinct strata that are parallel to one another. Joints are fissures in rocks produced by shrinking, &c., and are often at right angles to the planes of stratification. The term cleavage is applied to those divisional planes which render a rock fissile, but which generally are not parallel to the planes of stratification. Common slate is a good example of this structure.

smaller ones downwards towards the rivers and streams that drain the country, forming natural ramps from the lower levels to the higher.

Denudation has also always had some effect in modifying the shape of all valleys; partly by the action of the sea as they rose from the water, and partly by the action of ice, frost, and rain, after they had risen: for, however small may seem the power in rain-drops to wear away rocks as they trickle down the side of a hill, the effects that they have produced, by their continuous action through the untold ages of geological time, is so enormous as to impress the mind of the observer equally with the more magnificent phenomena of the volcano and the earthquake.

I know that it is quite possible for the professional surveyor to map all these things quite correctly without understanding anything about them, but to the military officer, whose great object is to combine correctness with rapidity, a clear idea of the Geology of the country that he is surveying is of immense assistance. Even in a district that is not mountainous, a knowledge of the thickness, inclination, composition, and order of the strata will greatly help him in obtaining the correct form of ground, and the proper position of the line of watershed; and will even sometimes enable him to detect errors in the plan of a country which he has never seen. But it is chiefly the constant habit of examining the surface of the land, and noticing the shapes of hills and valleys, that gives to the geologist an eye quick to take in the form of ground, and to distinguish between the principal and the minor features.

The position of houses and villages depends a great deal on the physical conditions of the country. For example, suppose a district to be composed of a stratum of sand between two beds of clay, the lower clay would be sure to be wet and marshy, for it would be overflowed by the drainage of the overlying sand, consequently but few houses and villages would be built upon it. There is a line of villages all along the base of the chalk escarpment north-west of London, the sites of which are determined by the springs.

With respect to roads, the reconnoitring officer has to observe of what they are made, and whether they are likely to become impassable in bad weather. In this Geology can assist him: When carried over sand, or a porous limestone, and made with good material, they are generally good in all weathers; but, if made on clay or other impervious rock and not well drained, they are sure to be cut up during rain. If the road is on the side of a hill, the dip and composition of the strata should be noticed to see if it is liable to slips, as is often the case when it rests on a sand or clay.

He has also to find out what are the best materials for repairing the roads and where they can be got. In choosing these he must recollect that they will be exposed to a crushing action as well as to friction among themselves, and that therefore tough as well as hard substances are required. By toughness I mean the resistance that a body offers to be broken or torn, in opposition to brittle. Rocks differ very much in these qualities; gypsum, for instance, is soft but tough, flint is hard but easily broken, while some are both tough and hard, as chert. Rocks which are composed of substances of unequal degrees of toughness are greatly inferior to those which are of the same texture throughout; thus granites

generally afford a material inferior to many trap rocks. Those granites in which the felspar is well crystallised are the worst for road purposes, since this mineral soon crumbles under pressure; while the granites in which hornblende prevails and the felspar is more compact are the best. The trappean rocks vary considerably in value as a road-making material; even the same quarry will afford stone of different degrees of toughness. Slate and limestone make smooth roads, but wear away rapidly when wet; some limestones, however, as the Bristol limestone, make good ones. Sandstone is much too weak for the surface of a road; it will never make a hard one.

The materials used in the construction of the road in the Crimea from Balaclava to the front, were whatever happened to be nearest. These from the harbour to the top of the plateau were oolitic limestones and sandstones, and all the rest of the way soft tertiary rocks. Now the whole of these, with the exception of a hard crystalline limestone in the oolitic series, are very inferior materials for roads, and when there is much heavy traffic, as was the case in the Crimea, are sure to be soon ground down into mud. But the beach outside the harbour of Balaclava is composed of compact greenstone, the very best road-making material known; so much so, that large quantities of it are brought from the Channel Islands for the streets of London; and if a geological survey of the country had been made this must have been found, and a good military road would in all probability have been made with it.

When operating in a mountainous country it is often most important to know whether a valley in the vicinity of the enemy can be safely traversed by troops, or whether it would be dangerous to attempt it in consequence of not being able to take possession of the heights on either side. Whether this is possible or not will depend upon the nature and hardness of the rocks, and on their power of resisting decomposition. Those rocks which weather easily will have smooth sloping sides, while those that do not will be bold and precipitous, and this is especially the case where soft rocks are interstratified with hard ones. No definite rules can be laid down for guidance, but there is a kind of instinct that seldom errs, which it is impossible to express in words, but which is founded on a close acquaintance with mountains, that enables the geologist to judge with tolerable certainty as to the nature of a valley, and whether its summit is likely to be inaccessible.

Mountains are in general most easily ascended from the side towards which the strata dip.

In looking for passes from one valley into another, either to turn the enemy's position, or to take precautions against our own being turned, it should be remembered that most of them are made by excavations in slate. The reason of this is obvious. As the ridge rose from the sea the soft slate would yield more to the action of the waves than the hard rocks on each side, and a depression in the ridge would be the consequence (fig. 7). The subsequent action of frost on such a fissile substance as slate would cover the sides with *débris* and make them smooth. If, therefore, a bed of slate can be discovered, it should be followed up to the top of the ridge, and a pass will most likely be found.

The nature of trees in forests, and the presence or absence of underwood

in them, depends greatly upon the soil on which they grow. Forests on a loose sandy soil are generally composed of firs and larches, with little or no underwood, and afford hardly any obstacle to infantry, while strong clay soils grow oaks and other trees, and support a thick mass of briers and small bushes, which often render them impassable.

The knowledge to be derived from geology about rivers and fords is very considerable. It has indeed been said that the course of all rivers is changed when they pass from one geological formation to another. This is perhaps rather too sweeping a conclusion, still there can be no doubt but that a change in the formation frequently causes a change both in the direction and character of a river, and that sudden deviations in their courses are often owing to dislocations of their beds.

The direction of a river depends of course upon the direction of the valley through which it flows. In a country where the principal valleys are valleys of elevation the principal rivers will run along them in the direction of the strike, and their tributaries will flow down valleys of denudation in the direction of the dip. But if there are large fissures in the strata the main streams generally flow through them, while the course of their tributaries is in the direction of the strike.

Those rivers whose course is over sandy rocks or chalk seldom or never overflow their banks, and when they do so they subside again quickly; but those that flow over clays, especially if their stream is sluggish, are very subject to floods, and, as the water is not able to sink, these floods often last for a considerable time. Sometimes a river may flow over a sandstone apparently sufficiently porous to prevent its flooding, and yet these appearances may be deceptive, the stratum of sandstone may be thin and underlaid by a clay, in which case the effect would be the same as if the river ran over the clay itself.

In the temperate zones, floods are caused by heavy rains, or the melting of snow, especially upon mountain ranges, and these floods are as variable in their recurrence and extent as the climate which produces them. In the torrid zone, on the contrary, the inundations occur with great regularity, for they are due to the periodical rains, which, in tropical countries, follow the change of the monsoon after the vernal equinox, and are thus dependent on the declination of the sun. For this reason the periodical floods of rivers in the southern hemisphere happen at opposite times to those in the northern. According to Humboldt the flood of the Orinoco is at its greatest height in August, while that of the Amazon, which is south of the equator, is in March.

Rivers that are flooded by the melting of the snow are most practicable in the spring and autumn. Those which flow from large lakes seldom overflow. The St. Lawrence, for instance, which drains a basin of 297,000 square geographical miles, maintains an almost perfectly equable flow in all seasons. The floods of the Lower Rhone arise from heavy rains falling in the valleys of the Côte d'Or and Jura mountains, which form the basin of the Saône.

The approach of a flood may often be known by the discoloration of the water, caused by the increased velocity of the current stirring up the bottom, and by the rain washing a greater supply of sediment into the river.

During the war in Spain a French officer was ordered to pass with his troops to the opposite side of the Cinca, a tributary of the Ebro. Not knowing that this river is subject to be suddenly swollen by the melting of the snow on the Pyrenees, he sent his advanced guard, consisting of five companies, across the river at night, intending to pass with his main body the next morning; but during the night the river had risen so much as to be impassable, and he had the mortification of seeing his advanced guard killed to a man by the guerillas without being able to render them the least assistance.

The power of rivers to move sand and gravel is often an important consideration in constructing military bridges. Detritus is brought down by rivers in two ways, first when small particles are mechanically suspended in the stream, and secondly by the friction of the water against the bottom rolling and pushing small pebbles and sand before it; but the first of these is of little importance, as far as military bridges are concerned, for they are generally only of a temporary character.

The velocity of a river is greater in the centre than at the sides, and greater on the surface than at the bottom, the water in these parts being kept back by friction, and the more the river winds the greater is this retardation. The mean velocity of a river is about four-fifths of the velocity of the surface.

A velocity at the bottom of three inches per second has been ascertained to be sufficient to tear up fine clay; six inches per second fine sand; twelve inches per second gravel the size of beans; and three feet per second stones the size of an egg. But this power of moving stones is greatly increased in countries where, during some part of the year, the cold is sufficiently intense to cause what is called ground ice to be formed. This is ice, which, for some unexplained reason, forms at the bottom of a stream, and by freezing round the stones tends to buoy them up, and allows them to be rolled along the bottom. Floods also, by increasing the velocity of the current, increase the pushing power of a river. The reconnoitring officer may estimate the power of a river to move detritus along its course by examining the pebbles and sand in its bed, distinguishing those that belong to the rock over which the river is flowing from those that have come from a distance, for, with very few exceptions, they must all have been brought down by the stream.

When a river falls into the sea its velocity is checked, and it consequently deposits a large part of the sediment which it had brought down: this, together with the sand and gravel that is pushed back into the mouth of the river by the flood tides, and heaped up there, forms what is called a bar across it. Most rivers have them, but their situation depends on a variety of local circumstances, which must be taken into account for each one separately.

A rapid river is generally able to keep its channel open; but, when it changes from rapid to slow, the detritus it contains in suspension is deposited, and it gradually fills up its bed; the pushing power is also reduced with the reduced velocity, and fords are formed. Thus most mountain streams have fords where they debouch into the plains; and a small river is often fordable at its confluence with another.

When any circumstance, such as a bridge, or a sudden bend in the

river, checks the velocity of the current, and hinders the movement of the gravel downwards, it tends to make a ford. For this reason in a winding river, fords are often found in the direction of the diagonal, joining two contiguous spits (fig. 8). Sir H. Douglas mentions that the Spanish army, with which he served, forded the Esla, in the campaign of 1812, without loss or difficulty, by taking advantage of this circumstance; and in the same manner he forded the Duero near Zamora, and several other formidable rivers.

A hard reef of rock will also often make a shallow across a river, there being deep water over the softer rocks; and in general fords are most likely to be found where the bed of the river is widest. As the sections of rivers at all sinuosities are irregular, they are not so likely to be fordable there as at the straight parts; and the bottom at curved parts is never firm throughout.

The nature of the rocks in the country through which the river flows, as well as the velocity and direction of the river, also influence the character of fords. In sandy countries, and where alluvial deposits are frequent, they may often be found suitable for infantry, but, on account of the yielding nature of the bottom, impracticable for cavalry or artillery.

Some rivers have permanent fords, others shifting ones, owing to their having a variable strength of current, which often cuts through a ford which had been previously formed. For this reason a river subject to floods is liable to have its fords destroyed, with the exception of those formed by harder reefs of rock. Sometimes however a flood may make a muddy ford passable, by covering it with gravel; or a decrease of velocity in the current may occasion a deposit of mud in a place that was before clean. The sudden destruction of fords is sometimes attended with very serious consequences: thus, on the 31st of August, 1813, Soult sent three divisions across the Bidassoa to raise the siege of St. Sebastian: a three hours' rain destroyed the fords by which the troops had passed, and they, having failed in their object, were obliged to fight their way back over the bridge at Bera.

In making a bridge the banks of the river should be firm, and not subject to land-slips; whether this is the case can generally be ascertained by examining their shape, composition, and structure.

The direction of a coast line often depends upon the direction, dip, and hardness of the strata. When they dip seaward, the abrading power of the waves on them is very small; but, when their edges are exposed, the loss is often great. Suppose that the diagram (fig. 9) represents a line of coast exposed to the north and west, and that the beds dip 45° north; then the resisting power to the waves will be great on the north coast, and will be the same along the whole line; this coast will therefore be nearly straight. But on the west side, where the edges of the strata are exposed, the waste will be greater; and, as they are certain to be of different degrees of hardness, many indentations will be formed. The reconnoitring officer would therefore look in this direction for harbours.

The uses of Geology to a staff-officer are so numerous, but so difficult to describe, that I think the best way will be to give you an example or two, to illustrate the way in which it can be employed. Suppose then that the route of an army lay up the valley of the Severn, between the

Malvern and Cotteswold hills. The structure of this valley is shown in the diagram (fig. 10). The geologist, on finding that the hills on the left were formed of highly-inclined Silurian schists, could confidently predict that the country on that side was mountainous and difficult; but seeing that the strata below him were horizontal, and that the same structure extended to the hills on his right, he would know that beyond their crest large table-lands existed without ever having seen them.

To take another case. Suppose the south-east of England to be a half-civilised country, without any good roads—as many countries are in which British troops have to operate—and suppose an expeditionary force to land at Romney, a geologist would see at once that it would be next to impossible to move an army over the clays of the Weald; but, on ascertaining that the hills on his right were chalk, he would know that he would there find a country that troops could not only move over, but manœuvre on, and would feel certain that this must continue for some distance.*

Again, how much has been said lately about using the chalk escarpment that surrounds London on three sides, and which has but few openings through it, as a line of defence for the capital.

These are some of the many benefits to be derived by military men from a knowledge of Geology; many others might be mentioned, such as the thickness and dip of the strata being often a valuable aid in judging heights and distances, or in showing which of two places has the command; but, in fact, so varied and so universal are its uses that it would be impossible to enumerate them all. It has been well said that "the acquisition of a new truth is equivalent to a new sense, enabling us now to perceive and recognise innumerable phenomena, which remain invisible or concealed to others;" and this new sense of Geology is continually pointing out to its possessor various facts, all more or less connected with a knowledge of the country that he is in, and therefore all more or less useful to him as a soldier.

Leaving now the practical applications of Geology to military science, I hope I may be allowed to say a few words about its indirect bearings. "As tennis," says Lord Bacon, in his Advancement of Learning, "is a game of no use in itself, but of great use in respect it maketh a quick eye, and a body ready to put itself into all postures; so in the mathematics, that use which is collateral and intervenient is no less worthy than that which is principal and intended;" and the same may be truly said of Geology. The mental discipline that a student receives from a study of the physical sciences, the love they excite of knowledge for its own sake, and the exercise they give his mind in grouping together facts of very different aspects, are of the utmost importance to all; while the habit of observing closely, the necessity of his observations being accurate, and the power of drawing conclusions proportional only to the evidence, are faculties that cannot be cultivated too highly by officers.

As an employment for leisure time Geology yields to none of the sciences, either in mental or bodily exercise. A practical knowledge of it can

* Since I read this lecture, I have been told that one of the questions at an examination in the Ecole Polytechnique, about two years ago, was, "What difficulties, geographical and geological, are presented by the coast of Sussex and Kent to a military landing?"

indeed only be obtained by dint of hard walking; while, on the other hand, Sir J. Herschel has pronounced that "Geology, in the magnitude and sublimity of the objects of which it treats, undoubtedly ranks in the scale of sciences next to astronomy." What these objects are is eloquently expressed by Professor Sedgwick, in his "Discourse on the Studies at the University of Cambridge." "By the discoveries," he says, "of a new science (the very name of which has been but a few years engrafted on our language) we learn that the manifestations of God's power on the earth have not been limited to the few thousand years of man's existence. The geologist tells us, by the clearest interpretation of the phenomena which his labours have brought to light, that our globe has been subject to vast physical revolutions. He counts his time not by celestial cycles but by an index he has found in the solid framework of the globe itself. He sees a long succession of monuments, each of which may have required a thousand ages for its elaboration. He arranges them in chronological order, observes in them the marks of skill and wisdom, and finds within them the tombs, of the ancient inhabitants of the earth. He finds strange and unlooked-for changes in the forms and fashions of organic life during each of the periods he thus contemplates. He traces these changes backwards through each successive era till he reaches a time when the monuments lose all symmetry, and the types of organic life are no longer seen. He has then entered on the dark age of Nature's history, and he closes the old chapter of her records." Surely no study could be more enticing than this; but it is as much to the immense variety of subjects connected with it as to the magnificence of its objects, that Geology owes its great charm. It is in fact the meeting point of zoology, botany, mineralogy, chemistry, and physics, each of which can be taken up as a separate branch, according to the inclination and opportunities of the student, while some or all of them may be pursued at every station in the world, and will render the dullest quarters pleasant and instructive.

With regard to collecting, although the specimens have certainly the disadvantage of great weight, yet this is in some measure counterbalanced by their imperishable nature; and Physical Geology, the branch which is most useful to soldiers, wants no collection at all, but requires only a hammer, compass, clinometer, note-book, and strong pair of boots.

As Geology is the most useful of all the sciences to a soldier, so is a soldier's profession the one of all others best adapted for its study. Remaining in one place sufficiently long to get well acquainted with its structure, and then moving to another perhaps far distant, and in a totally different formation, he has opportunities of studying Physical Geology which few can hope to possess, while at the same time he has ample leisure for reading and working indoors; and as in the course of his life he visits nearly all quarters of the globe, and sometimes goes into unknown, or but half-explored, countries, he may fairly hope to do good service to science, as well as have an inexhaustible source of occupation and enjoyment.

The study of Geology is greatly assisted by the two auxiliary sciences of Palæontology and Mineralogy, which bear somewhat the same relation to it that algebra and calculus do to mathematics; they are the means by which many of its problems are worked out. An extensive knowledge of

both is essential to any one who wishes to study the subject deeply, but for all practical military purposes a slight acquaintance with them is quite sufficient. To be able to distinguish the principal minerals of which rocks are composed; to have a general idea of the different forms of primary, secondary, and tertiary life on the earth (remembering that it is of more use to know the habits and mode of life of one common and characteristic form than to know the names only of fifty rare ones); and to have an eye so far educated as to be able to recognise similar fossils when found in different rocks is all that is required of the military geologist; for it is seldom of consequence to him of what age a rock may be, or to what formation it belongs, he only wants to be able to trace it out and so find it again in other places.

His attention should therefore be principally given to Physical Geology, the arrangement and structure of rocks, and the various ways in which they have been formed. Let him remember, that, although the elements of Geology may be learnt in the lecture room or from books, it is in the field alone, among the mountains, by the roadside cutting, or the sea-cliff, that he can learn to make any use of them. Let him take his hammer and his note-book, and go out into the country, and examine sections with his own eyes. Let him give up thinking that collecting fossils is the end and aim of all Geology; but let him endeavour to learn the dip, composition, and thickness of the strata, and the general structure of the district around him. Let him look for signs of denudation and metamorphic action, for faults and fissures. Let him consider how and when the hills, valleys, and plains were formed; and, above all, let him try to make a geological map of the country he is in, correcting it afterwards by the best one that he can procure. It is by studies like these that he will obtain a really practical and useful knowledge of Geology, and will not be in danger of mistaking cross-bedding * or cleavage for planes of stratification, and alluvium or wash † for rocks *in situ*. He will also find that he has acquired a new power, that will not only expand his mind and heighten his pleasure for scenery of every description, by enabling him to trace its history in its form, but one that will greatly aid him in nearly all his military duties.

List of books recommended—

Sir C. Lyell's Principles of Geology. Ninth edition. 1853. Murray, London.
Sir C. Lyell's Manual of Elementary Geology. Fifth edition. 1855. Murray, London.
Sir H. De la Beche's Geological Observer. Second edition. 1853. Longman, London.
J. B. Jukes's Student's Manual of Geology. Second Edition. 1862. A. and C. Black, Edinburgh.
J. B. Jukes's Popular Physical Geology. Reeve and Co., London. 1853.
D. T. Ansted's Elementary Course of Geology, Mineralogy, &c. Second edition. London. 1856.
J. Phillips's Treatise on Geology. Longman. London. 1852.
J. Phillips's Guide to Geology. Fourth Edition. Longman. London.

* When a stratum is made up of laminæ running in an oblique or waving direction. Also called false stratification.

† A term applied to the detritus of a rock that has been washed by rain to a lower level.

Friday, March 28th, 1862.

W. STIRLING LACON, Esq., in the Chair.

ON THE CAUSES OF SICKNESS IN THE ENGLISH WARS, AND ON THE MEANS OF PREVENTION.

By E. A. Parkes, M.D., F.R.S., Professor of Military Hygiene in the Army Medical School.

It is quite a truism to say that the great losses in war are not owing to shot or steel, but, like many other truisms, it is more often repeated than comprehended. Even to the mind of the soldier, the strife and peril of the battle-field throw into shade the more secret yet deadlier foes by which oftentimes campaigns are really decided and victories are really won. And yet, if there be anything a soldier ought to study out of his immediate profession, it should be those conditions which, in so many wars, have caused such losses by disease, that plans the best considered have been abandoned, courage the most heroic has been baffled, and causes the most sacred have been lost.

Our own army does not, perhaps, offer so many examples of these disasters as the armies of other states, but even with us there is a long and sad catalogue of unfortunate and unhappy enterprises, and a terrible list of soldiers' lives which have not been taken on the battle-field. As it is manifestly a matter of greater interest to review our own history than to turn to the larger and darker experience of other nations, I shall venture to attempt the enumeration of the chief causes which have led to great losses by disease in some of our wars. The subject is, however, too vast to be treated in a single lecture, and all I can venture to do is to give a rapid summary, and to illustrate it by a few examples.

As far as diseases are concerned, the history of almost all our wars presents a remarkable sameness. The same results on a larger or smaller scale repeat themselves. We are taught with what a terrible precision the same causes have stamped their marks on successive generations of soldiers, and how the pitiable history of one campaign might almost be stereotyped for nearly all the rest. Nor are these causes in any way peculiar, recondite, or mysterious. We are astonished to find how simple they are, how obvious, how apparently inadequate to produce such large results.

A writer, in giving an account of the great loss on one occasion among British troops, when, out of 7,000 men, 5,000 men were sick at one time, after enumerating the very simple conditions which had led to this end, says,—

"And yet when anxiously asked by the officers in command, what extraordinary cause could be assigned for an amount of sickness and

mortality truly alarming, something of incredulity has stolen over the countenances of my hearers while the natural causes above described were detailed, so little are we disposed to believe that great effects can be produced by the action of common causes."

But so it has always been. That the causes are common is the secret of their strength; they are ever at hand; even waiting, so to speak, for opportunities; apparently weak, they are in reality all-powerful; they are like the geni, who, in the story in the "Arabian Nights," the fisherman let out of the vase. At first there was a little cloud, which he could enclose with his hand, but presently there appeared a gigantic shape, clothed with power and irresistible in strength.

Of the early English wars the record is so imperfect that it would be waste of time to refer to them. Even of the wars of Marlborough we have but scanty medical accounts. We know that Marlborough had the reputation of being very careful of his wounded men, and it is said that he made a point of paying frequent visits to his hospitals. Doubtless he brought his extraordinary administrative powers to bear upon the medical, as on all other parts of his army. But of the exact losses by disease in his campaigns I believe little or nothing is known. They are supposed to have been small, as he was always able to bring a large number of men into the field, and England, at that time so comparatively thinly peopled, seems to have easily supported the drain both of men and money.*

Of the wars in Flanders and Germany in 1742, and of all subsequent wars, we possess tolerably good accounts, although the exact statistical reports and tables of our own day were quite unknown, and it is only from chance passages that we can form a rude numerical idea of the amount of sickness and mortality. The description of the diseases however, and of their causes, is for the most part both full and accurate.

1. Of the earlier expeditions after the wars of Marlborough, perhaps none was attended with greater losses, or excited more strongly the public feeling, than the unfortunate attack on Carthagena in 1741, under Vernon and Wentworth. It was not the first of the western tropical expeditions in which enormous losses had occurred, but the failure was so sudden and so overwhelming that it created an unprecedented sensation. To the military features of the campaign I need not refer; the dissensions between the commanders of the land and sea forces; the feeble movements of the general, and the vain courage of the troops, are sufficiently known.

Scarcely had the troops disembarked than sickness commenced. The diseases were malignant malarious fevers, scurvy, and bloody flux. The Spaniards looked down from their walls which they were scarcely called on to defend, watching curiously the dwindling away of their besiegers, till the rainy season of 1741 set in. The diseases then increased at a rate so fearful, that, to avoid complete annihilation, the force was hastily reembarked. It is said that no less than 3,425 men perished in two days. In a few weeks, in fact, the army had been almost destroyed, and we are told that "its poor remains were afterwards almost totally cut up in the sickly season in the island of Cuba."

* The greatest losses appear to have occurred during the sieges, especially those of Tournay in 1709, and of Aire in 1710. In this latter siege the killed and wounded of the allies were said to be 7,000, and the sick double that number.

The causes of this tremendous catastrophe were matters of common talk and tradition among army surgeons for many years afterwards. Two grand errors were committed; errors which we must put in the first rank among those conditions from which British forces have largely suffered in war.

The first of these was that old error, a most imperfect commissariat. We are not acquainted with the exact rations issued at Carthagena, but the presence of scurvy, which prevailed both in the army and navy, but most in the former, proves at once that fresh meat and vegetables were entirely wanting. The scorbutic dysentery, which soon succeeded, shows us, as certainly as if the diet lists were before us, that hard salt beef and pork and biscuit formed the miserable allowance, scarcely deserving the name of food, which was issued to these men.

The effect of insufficient food of this kind is to cause some diseases ; to predispose to many more. It is in this last circumstance that its great strength lies; malarious fevers are intensified by it; slight atmospheric vicissitudes, and other common agencies which fall harmless on the well-nourished body, tell with fatal effects on the enfeebled frame.

In a great number of the English wars an inefficient commissariat has been the bane of the army: I will select two or three other instances of the same fact. Perhaps the expeditions to Burmah, in 1824, and to China, in 1840, offer the best examples. In both cases the scene of operation was to some extent malarious, and in Burmah the worst time of the year, at the commencement of the south-west monsoon, was unfortunately chosen for the commencement of operations. But in both cases the cause of the immense mortality which ensued, or at least by far the most potent cause, was the food which was issued to the men. In both cases it was thought that men could be maintained not only in health, but in fighting condition, upon a diet so bad that no slave-owner in any part of the world or in any age of the world would have given it to his slaves. Wretched cattle hastily purchased and driven to Calcutta were there as hastily salted, and on this wretched meat and on almost as wretched biscuit the troops were kept, when within a few days' sail there was a land of wheat, of rice, and of fresh vegetables without end. To the immense mortality in the Burmese war I need scarcely refer. In three or four months some of the regiments lost half their strength; in eleven months 1,311 men died out of 2,716. The 13th Foot lost by disease 341 out of 608 men, or 56 per cent. So general was scurvy that the surgeons were in the habit of examining the gums of the men before a skirmish, to prevent any men having symptoms of the disease from advancing, as wounds received in that condition of body are most intractable. Malignant malarious fever, intensified by the state of the body, and scorbutic dysentery were the great agents of destruction.

Twenty-six years later, in the expedition to China, the same tragedy was repeated almost without variation. The history of the Cameronians may be taken perhaps as a type of the fate of the whole force, although the amount of sickness was greater than that which prevailed in some other regiments. The Cameronians landed at Chusan, a splendid body of men, 900 strong, on the 5th of July, 1840; in the first week in August 500 were in hospital; towards the end of August less than 100 mustered

on parade; later in the season the *débris* of the regiment, under 200 men, were sent to Manilla to recruit, and of these but a fraction ever saw their colours again. The bloodiest battle would have been mockery to this. Doubtless they were to a certain extent in a malarious country, but the malaria was not sufficiently intense to cause so great a loss. Again the simple cause is to be found in the diet. Nothing lives so long as a departmental tradition, and the errors of the last naval expedition from India were repeated in this case without variation. I have selected these two campaigns as the strongest examples of the paramount influence of diet, but many other instances also exist in our wars of the effect of an insufficient commissariat. Even in such comparatively slight operations as the first two Caffre wars a large proportion of the men became scorbutic; and in the first year of the Crimean war a diet so insufficient that any one accustomed to the subject would have been able at once, on being informed of the amount, to foresee the inevitable result, was deemed sufficient to support the strength of the men in the most trying and exhausting of wars.

In the wars of Marlborough, and in Flanders and Germany in 1742 and in 1760, the men were better fed than in many later campaigns; salt meat seems happily to have been little used. The colonels of the regiments appear to have been the chief purveyors: each colonel contracted with butchers, who drove with the army herds both of sheep and oxen for slaughter. Fresh meat, at any rate, was thus procured, and we know from the writings of Donald Munro that in 1760 the army surgeons strongly insisted on the issue of bread and fresh vegetables; fruits also were largely used, and in this way the ravages of scurvy appear to have been almost prevented.

In the wars towards the end of the century and up to the long peace the commissariat arrangements appear to have been inferior to those of eighty or sixty years before. Some of the mortality in the Peninsular war may be certainly ascribed to an inefficiency in this respect. It would seem unnecessary to allude to a point so self-evident as this of insufficiency of food, did not the repetition of the error prove that it is one which must be expected to recur. The first rule in war must be to provide a diet in the highest degree strengthening and nutritious; the diet of peace is quite unequal to maintain the forces of the body when exhausted by the mental and physical exertions of war. It may seem an expensive matter to provide a diet which is sufficiently varied and sufficiently strengthening, but it is not so really. A great army surgeon has said "Economy of lives is the truest economy of the state," and no saving can be more like waste than the saving which sacrifices men's lives.

2. The second great error committed at Carthagena was undertaking operations in an unhealthy site and with an unhealthy season impending. Of course one can understand that a military officer, for the purpose of accomplishing some military end, may deliberately occupy an unhealthy site and knowingly sacrifice a certain number of men. There are examples of this in our wars; for example, in the attack on Java in 1811, when a marshy site was occupied at the outset; but even here the military arrangements were obliged to be somewhat modified and hastened in consequence of the rapidly increasing diseases among the

troops. But unfortunately there are many instances in which unhealthy sites have been chosen without any forethought, without any deliberation, and apparently either in the belief that men were made of iron and could not be injured, or that the stories of diseases being produced by locality were mere foolish inventions and old wives' tales. Although Vegetius tells us that the Romans, the great masters of the art of war, took the extremest care to choose good encamping grounds, and even appear to have made the plans of their campaigns subsidiary to this prime necessity, the point has been too much neglected in all modern wars, and even in the English army. Of the many examples of this I will select one or two only. In 1796 a body of troops about 9,000 strong were ordered to San Domingo; some of the regiments were collected from the West Indies and others from Ireland. The Irish regiments had been rather hastily recruited and typhus prevailed among the men, but it was thought that if time were allowed this disease would be got rid of; time, however, could not be given, and the expedition was launched against San Domingo. Now in 1780 Donald Munro, an army surgeon of reputation, had described with some care the unhealthy and the healthy places of San Domingo, and in 1793 portions of the island had been occupied by our troops. It can therefore be scarcely credited that the most unhealthy spot in the whole island, Port-au-Prince, was chosen for the encamping ground. There were not wanting those who supposed that the general had been deceived by persons interested in the choice of the site: be this as it may, the troops were crowded together on a low marshy alluvial plain, where good water could not be procured, which was shut out from the sea breezes by hills, and was completely exposed to the land-winds. As if this was not sufficient, the diet was bad, and salt meat without bread and fresh vegetables formed the staple of the food. With a view of increasing the strength of the body, an old custom of the English army was in full force, and the men received large rations of rum. Of all the errors committed in our service this seems to be the most persistent and the most ineradicable. Although the best army surgeons had at that time protested against the use of rum in hot climates, although in the American War of Independence the uselessness of rum had been proved almost immediately before, although at San Domingo the immense amount of sickness showed that it was producing no good result, the fatal practice was persevered in. That army had everything against it, and the result was certain; it was almost literally annihilated by yellow fever and dysentery. A writer who saw the sad catastrophe calls San Domingo "the grave of the British army," and says "The army languished and dwindled away without the least service to the cause it was meant to support." It is impossible to know the exact amount of the mortality. Many regiments 800 and 900 strong had only fifty or one hundred men left. All lost largely, and it is probable that few of that gallant force ever did the State more service.

The expedition to Walcheren gives perhaps a still better example of the effect of a marshy and malarious locality. In 1747 Sir John Pringle, one of the most celebrated in the long list of illustrious army surgeons, described the great unhealthiness of South Beveland and of Walcheren. So great was the sickness that in many corps 6-7ths of the men were in hospital at that time.

This low tract of ground, won in almost modern times from the sea, which is everywhere swampy, and where good water cannot be procured, had not lost its ancient and well-known reputation, when in 1809 the finest expedition that ever left the British shores landed in the highest health and vigour. They found there a Dutch regiment which in three years had lost 715 men out of 800: this was the type of their own fate. This great force, nearly 40,000 men in all, was destined to attack Antwerp; it never even approached that fortress. It sailed on the 28th of July from England, invested Flushing with 17,000 men on the 7th of August and took it on the 15th: twelve days later, the men were falling sick so rapidly that the guards had to be relieved twice daily. On the 14th of September, seven weeks after leaving England, out of the 15,000 men in Walcheren 10,000 were in hospital. The deaths at last reached sixty daily, at which rate the whole force would have been destroyed in 250 days. Four months after landing, the army, utterly disorganised, was hastily re-embarked. "The expedition"—to use the words of an eye-witness—"had been productive of nothing but mortification, misery, and disgrace." The diseases were malarious fever and dysentery.

Let me take another example on a smaller scale. In the American War of Independence, two battalions of the 71st Regiment were encamped, contrary to the advice of Robert Jackson, the prince of army surgeons, and of the inhabitants of the country, on the marshy banks of the Pedee river. The men fell sick so rapidly, that the post was ordered to be abandoned. It was then found that it was almost equally difficult either to keep or leave the post. At length, after a great deal of trouble, boats were collected, the sick men were placed in them and were sent down the river, and it is said that few of them were ever seen again. The rest of the force retired from the banks of the river, and, to show the deadly nature of the encamping ground, it was said that the men improved vastly in health even on the march.

The same mistake of a malarious locality being taken as an encampment, was seen in the second American War in 1814, at the siege of Fort Erie. And there are other instances too numerous to bring before you. Even the great Duke himself was said to have crippled his forces by a prolonged sojourn in the marshy plains of Estremadura.

As in the case of food, it may be said to be impossible that errors of this kind can occur again—that, with the present organisation of the service, before any campaign is undertaken the country will be investigated, its features known, and its influences estimated, and that the campaign will be entered upon with a full knowledge of all the circumstances which can affect the men. But we have unfortunately evidence that the immense influence of a malarious locality is not even now sufficiently appreciated by our soldiers. Under some circumstances indeed it is impossible but that campaigns must be undertaken in unhealthy localities and in marshy countries. In that case certain precautions must be adopted; these precautions have relation chiefly to the arrangements of the camps and bivouacs so as to shelter the men as much as possible from unhealthy emanations; to arrangements of guards, so as to expose the men, especially at certain hours of the night, as little as possible; to the use of an extremely nutritious diet, for that has been

found to have a great effect in lessening the susceptibility of the body to malaria; to the supply of good water, and to the employment of various drugs which have been proved to produce, more or less, immunity from attacks of malaria. If malarious countries are entered, and these and similar precautions are taken, the troops will escape with as little harm as can happen under the circumstances.

3. I must now pass on to another condition. The wars in Flanders in 1742 and in Germany in 1760 have been very carefully recorded; perhaps more so than any other war, with the exception of the Russian war of 1854-5. In both these wars, at certain periods, the men were exposed greatly to inclemencies of weather. It was then seen that if men are well fed and can be kept dry they can bear great cold. The winter of 1742 was extremely severe, and in April, when the troops commenced their march, there were extraordinary snows for seventeen days. The troops marched through these storms, but were every night received into warm houses. Out of the 16,000 men not twenty were lost. Again, in the German war in 1760, some regiments made a winter campaign on the borders of the Lower Rhine; they were exposed to great inclemencies of weather, to great hardships, and to extreme cold, yet they were very healthy, much more so than the troops left in the fixed camp at Warburg, who, it may be supposed, must have been in the possession of much greater comforts. This was owing to their good food and good clothing. At that time, 1760, every soldier wore a flannel waistcoat, a custom which has now unfortunately disappeared. This custom was commenced by gifts from the Quakers to the army in 1745-6, and it was found to be attended with the greatest possible benefit. In 1760 the Government issued warm clothing of this description, and in addition there was a very large private subscription in England, and blankets, great coats, underclothing, shoes, stockings, &c., were given to the men. The men's blankets were carried on horses, and were wrapped in waterproof clothing. Each company had its own horses, which kept up with the men on the march.

The same fact, that men can bear great exposure to cold if properly fed and clothed, was also established in the American War of Independence. Some of the Rangers were out during the winter, and escaped almost entirely the diseases produced by cold. They attributed their immunity in a great measure to the use of hot ginger tea. Every man carried a piece of ginger in his pocket, and would on no account be without it. With this they made hot tea, and they found this much more comforting than spirits, which appear to have been in a great measure disused among them. Hot infusions of garlic and infusions of horseradish were also used for this purpose, until the more common employment of hot tea and coffee supplied us with means which may perhaps be considered even better adapted to protect the body against exposure to weather.

The same fact was again seen in the American War of 1814; in the partial winter campaign, the men bore the cold without great difficulty, being very carefully protected from the weather.

The same fact was again shown in the celebrated marches in Canada in the rebellion of 1837, and similar marches appear to have been repeated with as much success during the last few months.

Although, however, it appears to be quite certain that if men are well

fed, and if the surface of the body be kept thoroughly dry, they can bear great exposure, yet few armies have been so well cared for; and exposures to inclemencies of weather must be put down as the third cause which has been productive of disease in our campaigns. Even the campaigns of Flanders and Germany to which I have referred give many examples of this; one of the best, perhaps, is the often-quoted case of what occurred after the battle of Dettingen. Previously the men had been extremely healthy, after the battle they were exposed to wet and cold for two or three days; the consequence was that an attack of dysentery occurred, and was so general that half the army were affected; had this occurred a few days previously it is by no means improbable that the strenuous exertions which alone won the battle of Dettingen would have been impossible. So also in 1760 there was at times a considerable amount of sickness from exposure to weather, in spite of the great care which was taken of the men. In 1799 another campaign in Flanders owed its chief disasters to the inclemency of the weather, and the gallant force of the Duke of York was, in fact, beaten by the elements.

It is impossible that a general in command can ever protect his men perfectly from inclemency of weather; armies must be expected to suffer from this to a considerable extent; the diseases it produces are of course catarrhs, inflammation, rheumatism, and dysentery. But it is satisfactory to know what great effect the measures to which I have referred can have: if men are well fed and are well clothed and covered with waterproof clothing (which will probably be found the greatest boon which has ever been given to the soldier, but which is not yet sufficiently appreciated in our army), if hot liquids are provided for them, and spirits kept from them, or at any rate issued in the greatest moderation, there is no reason to think but that troops will bear a great deal of exposure to inclemencies of weather. Even the winter in the trenches before Sebastopol, had these means been available, might certainly have been met with comparatively little loss. But if from poverty or from defect of transport the warring nation cannot clothe and feed its troops, its plan of campaign must be adjusted to its circumstances, or it must be prepared to encounter a great mortality.

4. But catarrhs, slight dysentery, rheumatism, and inflammations are not the only diseases which affected the troops in the wars in 1742 and 1760; in both cases they suffered, though to a comparatively slight extent, from the spotted typhus and the putrid dysentery—diseases which have been the grand scourges of armies in temperate climates, in the same way as cholera and yellow fever have been the destructive agents in the tropical wars. The spotted typhus, the great typhus of armies, is, perhaps, the most terrible disease of all; wherever men are closely crowded together in ill-ventilated, unwholesome dwellings it is sure to appear. If scurvy be also present, it then attains its greatest intensity, and commits ravages which are truly astonishing. It has often passed from the army to the civil population, and has half dispeopled towns and even districts. Its ravages in the English army have never been comparable to those which have occurred in foreign forces, and, to give an idea of its powers, permit me to allude to a few examples of the effect of this disease among some continental troops.

In 1620 the Bavarian army in a few months lost in Bohemia not less than twenty thousand men from spotted typhus, and the disease being carried into other parts of Germany, obtained the name of "the Bohemian disease," just as, in the same way, on a later occasion, the typhus carried back from Hungary received the name of "the Hungarian disease." In 1628 and 1632 the Swedish army under Gustavus Adolphus carried typhus into Northern Germany, and the population was so destroyed that fifty or sixty years later villages remained without inhabitants. The wars of Louis XIV. were always followed by this disease, and the losses of the French army were enormous. But it was in the wars of 1812 and 1813 that its greatest ravages were seen. In May, 1812, the Bavarian army serving among the French numbered 28,000 men; in February, 1813, there were only 2,250 under arms. The great destroyer was typhus. In August, 1813, the first Prussian army consisted of 37,728 fighting men, in November of the same year it reached the Rhine with 11,515 men, having lost 16,000 men by the sword, and 10,000 men by disease, almost entirely typhus. Even this was trifling compared with the enormous losses among the French army. Not only the army but the civil population suffered fearfully. It is impossible to enumerate the hecatombs of victims; in Mayence alone the French lost in six months 17,000 men from typhus. It is impossible to overlook the effect which this must have had upon the fortunes of the campaign.

In later wars the same fact has occurred. I need scarcely refer to the great losses, even yet not perfectly known, of the Russian army in the Crimean War, and to the losses of the French army in the spring of 1856, when more than 17,000 men perished in less than three months, and when the highest authority stated that the safety of the whole French army was endangered by the outbreak. In the war in Flanders in 1742, and again in 1760, the great cause of the spread of typhus appeared to be the state of the hospitals. If typhus once enters a hospital, unless that hospital be extremely well adapted for the treatment of this disease, and if it once attains any proportions, it spreads among the patients with astonishing rapidity, and the hospital becomes a veritable pest-house. The only plan to adopt under these circumstances is that which was carried into effect by Sir James M'Grigor in the Peninsular War. Typhus had broken out in some of the hospitals; Sir James M'Grigor broke them up and distributed the sick among the villages, and in this way, in spite of bad food, in spite of bad attendance, and in spite of exposure, the disease was arrested. Anything indeed is better than a deficiency in the supply of air. There is no doubt that with proper sanitary precautions, the spotted typhus, terrible as it is, may be almost entirely put a stop to. It must, however, be considered as taking the fourth place in the causes which have produced disease in the British army.*

* Whether or not the circumstances to which I have referred, viz. great overcrowding and vitiation of air from organic impurities derived from respiration, will absolutely generate typhus *de novo*, is yet uncertain. In all the English wars, there has always been plenty of typhus-poison, waiting for favourable conditions to assume activity. This arose from the peculiar system of recruiting. Even in the Crimean War, we saw the relics of a system constantly resorted to in the last century to raise men. Commissions and commands of regiments used to be given to those who collected a certain number of men. Every low

It has never been absent from any considerable European war till the wise sanitary measures adopted in the Crimea showed us an army with scarcely a case, while two other armies under the same circumstances lost numbers of men.

5. The other disease to which I have referred, the putrid dysentery, is one which has prevailed to a still less extent, in the English army, than the spotted typhus. It prevailed to a certain amount in the wars of 1742 and 1760, and in the Peninsular War during a short time. Arising from various causes, from exposure to cold, from bad weather and bad food, it is also propagated by contagion, and appears, indeed, to give us an example of a disease acquiring contagious properties. This fact appears to have been first indicated clearly by Sir John Pringle, but it has been subsequently confirmed by a great number of observations in the French wars, and in other cases. As in the case of typhus, there is no reason to doubt that proper sanitary measures will lessen the spread of putrid dysentery. It must, however, I believe, take the fifth place among the diseases which have caused losses in the English wars.

6. I must now pass on to another condition, which possibly might have come before one or two of the others. In 1760 the head-quarters of the troops in the German war were at Paderborn in Westphalia. There was much sickness, and great dissatisfaction was expressed in England much in the same way as in the winter of 1854–5. The diseases were putrid dysentery to a slight extent, spotted typhus to a considerable extent, and other forms of fever, among which doubtless was the disease now known by the name of typhoid fever. These malignant fevers arose at the standing camp at Warburg, and were carried to Paderborn. They were produced by the condition of the camp, which had been inhabited for a very considerable time. Both it and the whole country around were covered with putrid remains. We are told that dead men and horses lay around in "infinite numbers," and that the bodies were only thinly covered by earth.

The unhealthiness of standing camps—unless the greatest care be taken to cleanse them—is one of the best known facts of army hygiene. The frequent shifting of encamping grounds is almost the only rule which has come down to us by means of which Alexander the Great so marvellously preserved the health of his men. The Romans also took the most special care for the cleanliness of their camping grounds, as indeed in all other matters connected with the health of their men.

Unfortunately, in modern armies the grand rule of paying the greatest attention to this duty has been too little regarded. In the English army it has perhaps been more attended to than in other armies, but even with us it is impossible to read the accounts (unfortunately too short) of the

purlieu, every infamous haunt, every jail even, used to be ransacked for recruits. Wherever these men went, they carried typhus, at that time the constant scourge of our towns and our jails. It gives one a strange idea of the making of a soldier, to read in Donald Monro's essay, published in 1764, a caution "that particular regard be paid to those soldiers picked up in the streets, or who have been taken out of the Savoy or other jails. All dirty rags from such people should be thrown away or burnt." Complaints of the introduction of typhus from this source are frequently found in the writings of army surgeons of the last century. Typhus was several times carried to the West Indies, and even prevailed there apparently to some extent.

camps even in the Peninsular War without perceiving what prolific sources of disease they were.

Let me take another instance of the effect of bad encamping grounds, as it illustrates one or two other points. In 1801 a force of 4,000 Europeans and 4,000 natives landed in Egypt from India. In June they commenced their march across the desert; they underwent hardships which Sir James M'Grigor thinks were never exceeded by any army. The heat was intense, the thermometer in the tents marked 118°, and at nine o'clock in the morning at three feet depth in the ground the thermometer marked no less than 69° Fahrenheit. Owing to the difficulty of carriage, no spirits were issued. In spite of all this the men were remarkably healthy, proving, what our Indian campaigns have also shown, that with proper precaution, and if spirits are avoided, great heat can be borne without risk. Having reached the Nile, the army descended that river for 400 miles, and landed at Ghiza. There they found the 89th Regiment very sickly; scarcely fifty men mustered on parade. This ought to have attracted attention, inasmuch as the 89th should have been considered to be the touchstone by which the sanitary condition of Ghiza was to be judged. However, the army was there disembarked, being then, to use the words of Sir James M'Grigor, "uncommonly healthy." In less than a week they sent into the hospital ten per cent. of their force; in three weeks there were a thousand sick out of the eight thousand men; in four weeks there were twelve hundred sick: then the army moved to Rosetta. We must therefore consider that no less than fifteen per cent. of that force had in that short space of time been in the hospital, and one-fourth of the duty-men in all probability must have passed through the hospital. The diseases produced in this short time were attended with very slight mortality; they were chiefly fevers which appear not to have been of malarious origin, but chiefly of that kind, yet little investigated or understood, which are known by the name of the bilious remittent, or the bilious typhoid, and the bilious relapsing fevers of the Mediterranean and Egypt. There were also slight dysenteries, and some ophthalmia, but no plague till afterwards, when the army got to Rosetta.

It was supposed at one time that the diseases produced at Ghiza were owing to the marshes in the neighbourhood, but this is rendered improbable; first from the fact that, as far as can be known from the accounts of the diseases, which are very short and imperfect, the malarious taint did not form any grand element in these diseases, and secondly from the following fact—Ghiza for months had been an encamping ground of a succession of bodies of troops—Turks, Mamelukes, French, and then English. The whole country was covered with putrid effluvia. At a subsequent period, when time had been given for the perfect dissipation and complete decomposition and elimination of all these putrid remains, Ghiza was again occupied and was found to be healthy; therefore it would appear certain that the condition of the camp was the cause which led to the great amount of sickness in the expeditionary force.

Filthy standing camps, then, giving rise to various forms of fever, typhoid being among the chief, and to other forms little understood, also to dysentery, and to cholera in some regions, must be put down as the next cause which has given rise to mortality in English wars. It is probable that this

cause will never again produce any great amount of sickness in our forces, inasmuch as not only is the necessity of the most perfect cleanliness in camps well understood, but in the present organization of the medical department, sanitary officers are appointed, whose special duty it is to insure the perfect and continued cleanliness of the camps.

7. I will now pass on to another head. The fatigues in war are excessive, and can only be borne by men whose frames are matured by age and constant physical exertion. Boys and immature young men are speedily destroyed, or only throng the hospitals. In campaigns every soldier ought at least to be twenty-one years old, and should have been accustomed to the most constant physical exertion and open-air exercise. Before a regiment goes on a campaign, it should be weeded of its immature men, who should form a corps of reserve, and be subjected to a thorough course of training, and be then sent on to join their regiment, when deemed fit to encounter the hardships of the campaign. The effect of exposing immature troops to the hardships of campaigns has been frequently illustrated. Some of the heaviest mortality in the Peninsular War was among regiments thus hastily recruited. In the Crimean War, during the second winter the troops were fortunately not called upon to undergo great exertion. Had they been so, in spite of all sanitary precautions, that young and untried army must necessarily have suffered very considerable mortality. Perhaps the best example in our annals of the effect of this cause is to be found in the history of the British Legion in Spain, in 1837, as given by Mr. Alcock. This body of men consisted of about 7,000 persons, hastily recruited, comprising Englishmen and Scotchmen, chiefly drawn from towns, and Irishmen who were more largely drawn from the open country. Almost all the force were either too young or too old. They landed in Spain during the winter. In the first few months after landing, one-third of the English, one-fifth of the Scotch, and one-eighth of the Irish were "rapidly swept into the hospitals." During the six months which succeeded their landing, they lost the "lives and services of 2,000 men," and the whole force was enfeebled and crippled for six months; no doubt they underwent very great hardships, were exposed to the weather, had bad food at some part of the time, and bad shelter; but they were not exposed to greater hardships than have often been met with little loss by seasoned troops. The great cause of their losses is to be found in the quality of the men, and it is worth observation how comparatively easily the Irishmen, drawn from the country and accustomed to open-air life and to the physical exertion of agriculture, bore the hardships which prostrated so rapidly the town recruits drawn from Scotland and England.

The often-quoted marches of Napoleon may be just alluded to here in reference to this point. In 1805 the so-called "Army of England" marched across France, a distance of 450 or 500 miles, with scarcely a straggler, and with scarcely any sick. In 1812 and 1813 the French army was an army of recruits, "boys who died by hundreds on the roadside." The Emperor bitterly complained, but his complaint met with no response. He had exhausted France by fifteen years of glory, and seasoned, hardened veterans were not procurable.

But even seasoned and veteran troops may be too highly taxed. Of this

there are not many examples in the history of English warfare. There are a considerable number in the history of continental armies, as in the army of Prussia in the time of Frederick the Great, and later.

Properly to train his men, to train them so that they shall be ready for great emergencies, to save them when saving is practicable, so that when necessary their whole strength may be called upon, must be one of the most striking powers of a great commander. The exposure, then, of immature young men to the hardships of war, hardships which must be undergone, must form the next series of causes which have given rise to disease in the English wars.

8. But now, supposing that the provident care of the Government and the skill of the general have succeeded in meeting all these conditions—have succeeded in providing well trained and seasoned men, in properly feeding them, in properly clothing them, and protecting them as far as can be done against inclemencies of the weather, in looking out for, anticipating, and providing for the causes which produce typhus, the causes which produce putrid dysentery, the causes which produce typhoid and other forms of fever—supposing that all this could be done, would an army be healthy?

In answer to this it may be said that it would be, that it must be, in a great measure, healthy. But there are still some causes which the soldier himself calls into action, and from which his officers can only in a very slight degree protect him. The agencies which the soldier himself thus calls into action are, especially, the want of cleanliness, which is so difficult to be enforced in war, the excessive use of spirits, and debauchery.

During any exertion it is an important matter to keep the skin perfectly clean. There are those who underrate the importance of this point, but they are mistaken. It is a point of prime necessity. Now in war such cleanliness is hardly possible to be enforced. Water cannot be procured, time perhaps cannot be given, and the soldier necessarily becomes extremely dirty. Hence there is a certain amount—no great amount, but a certain amount—of ill-health proceeding from this cause alone.

Whenever an army has been kept from spirits, although it has been placed otherwise under unfavourable conditions, its health has been good. Some striking examples of this may be taken from the American War of Independence, among the American troops. At first the American troops in the revolutionary war were unhealthy. After a time they ceased to be paid—funds were not forthcoming to pay them. They then became very much healthier—in fact extremely healthy. The same thing occurred in 1814. In that war the American troops were also unhealthy at first. They ceased to be paid, they ceased to purchase spirits, which previously they had indulged in, and again they became healthy. A surgeon who witnessed both these campaigns states, and very truly states, that "when the soldier is poor in money he abounds in health." The same effect of abstinence from spirits being attended with an improved state of health of the troops has been witnessed often in the English army. The case of the "illustrious" garrison of Jellahabad is a striking instance. Another most striking instance is given by Sir John Hall in the last Caffre war. The troops were exposed to great hardships and inclemency of weather, and yet remained extremely healthy, in consequence, mani-

festly, as appears from all the circumstances of the case, of the fact that spirits could not be issued to, or procured by them. But perhaps the most interesting example of this fact is to be found in the celebrated Cornwallis campaign of 1781, in which a body of men made a long and fatiguing march of more than 2,000 miles, were exposed fully to inclemencies of weather, were supplied by a commissariat which was rather indifferent, and yet remained extremely healthy. Dr. Chisholm, the surgeon of the 71st Highlanders, shall however narrate this case. I will read an extract from his book giving an account of this celebrated march. He calls it "the most remarkable campaign of the American Revolutionary War, owing to the dangers, fatigues, and privations sustained by the army in the course of it:"—

"They effected a march of nearly 2,000 miles through a poor country, inhabited by inveterate enemies, always more than 200 miles from their resources; forded many large, deep, and rapid rivers at the hazard of their lives; fought one pitched battle against thrice their number; were almost constantly engaged in skirmishes; were deprived of rum or any strong liquors; were for weeks successively reduced to the scanty support which a few heads of Indian corn, and a precarious very limited allowance of lean fresh beef afforded them; had no shelter from the inclemency of the weather, or the damps of the earth and night, but a single blanket and a few boughs of trees hastily put together in the form of wigwams. These hardships, fatigues, and privations they were enabled to support by the example shown them by their excellent and amiable commander; by the exercise of marching being alternated by rest every third day, when practicable; by parading in clean linen once every marching day and twice every halting day, being obliged to clean and bathe themselves every day; by the men being obliged to wash their shirts and waistcoats and pantaloons themselves; by a necessary abstinence from strong liquors; and, finally, by what may be considered as not the least cause, their pursuing, not flying from, an enemy. The regiment I was surgeon to, the 71st Highlanders, composed a part of this truly gallant army; they consisted of about 600 men, and the average number of their sick during this arduous service was about twenty-five, exclusive of wounded, and they were all trifling cases."

Now here the great immunity from sickness may be considered to be dependent,

1. Upon abstinence from liquors.
2. Upon the enforced cleanliness.
3. Upon the rest every third day.

The commissariat, though indifferent, was not extremely bad; the men had fresh meat, at any rate, and appear also to have had corn, and possibly other vegetables. Of these causes the abstinence from strong liquors must be put down as the most important. In the long catalogue of wars I have not been able to find a single instance in which the use of spirits has been proved to be useful, and there is a very large number in which it has been proved to be detrimental. There are only three ways of keeping men from the excessive use of spirits. The first is to supply them with good malt liquor, and with red wines which contain a small per-centage of alcohol. The supply of red wines of this kind was

formerly strongly urged by Sir Gilbert Blane, the celebrated naval surgeon. The use of these wines is not merely negative as a substitute for spirits, but also positive, for by their use a large number of salts, neutral and acid vegetable salts, are supplied to the body, which are of the highest importance to the nutrition of the system, and are themselves no mean antiscorbutics. The second mode of preventing men from getting spirits is of course by camp regulations. We have seen this attempted in the present American War, for a special Act has been passed by Congress for the purpose of hindering the men from purchasing spirits—a plan, however, which is always liable to considerable evasion. A third means by which men might be kept from the excessive use of spirits, would be to teach them how really ineffective and inoperative their use is in preventing them from suffering from diseases, and how many diseases the excessive, or indeed the even moderate, use of spirits may itself give rise to.

The third cause, which the soldier brings upon himself, and which has caused a great deal of sickness in some campaigns, has been debauchery. This, of course, is a point which can only be prevented, as far as it can be prevented, by camp and police regulations.

Such are the eight different and principal causes of mortality in our wars. I have arranged them in the order in which, looking over the history of English campaigns, I find they have produced the greatest amount of sickness. I have considered them separately or enumerated them separately for the sake of convenience, but in almost all campaigns two, or three, or four, or perhaps all of them, have been acting together.

There is no doubt that to a great extent these causes are preventible, but to prevent them would require that those in authority should fully recognise their existence and meet them with continued energy. To prevent them requires no special science, no peculiar appliances, but only the exercise of common sense and of knowledge which every soldier ought to have. The Romans certainly applied and acted upon rules which we must also apply, and acting upon them they appear to have escaped, at any rate to a considerable extent, those immense losses and tremendous catastrophes which have so often befallen modern armies. Their forces penetrated many countries and underwent many difficulties; the forest, the marsh, the desert, the cold mountain pass, the torrid plain, were traversed by them with impunity. Shall we, who boast a dominion as extensive and a knowledge more subtle and profound, fall short of the results obtained by those old masters of the world? If so, it will not be because our difficulties are greater, nor because our knowledge is less, but because we refuse to hearken to the lessons proclaimed to us from the camps and battle-fields of those thousands of British soldiers who in times gone by have fallen victims to the preventible diseases of campaigns. We must not suppose, because those lessons are so obvious, that they can be suffered to be forgotten. A writer whose name will assuredly be hereafter placed by the side of those of Robert Jackson and of Henry Marshall, says, "All errors should be treasured up in our memories. Although the past cannot be redeemed, it ought to suggest lessons for the future."

And Ranald Martin goes on to cite those memorable words of Samuel

Johnson, which, written in 1771, are still full of meaning, and have lost nothing of their truth and force.

"The life of a British soldier," wrote Johnson, "is ill represented by heroic fiction. War has means of destruction more formidable than the cannon and the sword. Of the thousands and tens of thousands that perished in our late contests with France and Spain, a very small part ever felt the stroke of an enemy. The rest languished in tents and ships, amidst damp and putrefactions, pale, torpid, spiritless, and helpless; gasping and groaning, unpitied among men, made obdurate by long continuance of helpless misery, and were at last whelmed in pits, or heaved into the ocean without notice, and without remembrance. By incommodious encampments and unwholesome stations, where courage is useless and enterprise impracticable, fleets are silently dispeopled and armies sluggishly melted away. Thus is a people gradually exhausted, for the most part with little effect. In this last war Havannah was taken, and at what expense is too well remembered. May my country be never cursed with such another conquest."

It is now ninety-three years since these memorable words were written, and it is only now that we may venture to hope that this country will not again be cursed with conquests that are scarcely less disastrous than defeats. Now at last an enlightened policy has been initiated, and the health of the soldier is, as Robert Jackson said it ought to be, "a primary consideration of the State." I venture to prophecy that in after times few reforms will be thought more important than that with which the names of Lord Herbert and Miss Nightingale, and others scarcely less distinguished, are now for ever connected; a reform in which the State both recognises a duty, and, as a reward, reaps an untold advantage. But it must be for the army at large and for the general public to support exertions which, without their aid, would languish and disappear. It must be for us, in fact, not to forget the teachings of the past, but to make them ever-living, that their warnings shall not be forgotten, and that their lessons shall not be unfruitful.

THE CHAIRMAN: I hope you will allow me to convey to Dr. Parkes your best thanks for his eloquent and most instructive lecture.

Friday, May 9th, 1862.

W. STIRLING LACON, Esq., in the Chair.

A NEW SYSTEM OF ARTILLERY FOR PROJECTING A GROUP OR CLUSTER OF SHOT.

By General O. Vandenburgh, N.Y.S.M.

For military purposes, gunnery has mainly had for its object, in its later attainments, the projection of a single shot, with increasing precision, range, and power, and, latterly, with especial efforts for augmenting the weight and magnitude of the matter, thus projected in a single mass. No argument is now required to show the value and importance of projecting a great shot, with great power and with great precision. There is, however, something besides the projection of a large single shot, which is equally legitimate as an attainment in gunnery, and of no less military importance. To uncover an enemy and penetrate his defences, it is necessary to concentrate the destroying power and matter in one body, in order to transfer it to one point. The object is to make that point vulnerable. When an enemy is uncovered, it is no less important to distribute the destroying force over the greatest possible area, compatible with the retention of a life-destroying efficiency at every point. Thus, if three 530-grain bullets could be projected simultaneously, one foot from each other, in the form of a triangle, with the same range and precision as a 12lb. shot, against an enemy in the open field, although the proportion of matter compared with the large shot, would be only as 1 to 57, they would yet cover and sweep a considerably larger area of space with a deadly and destroying force. The power it is true would be less within the space covered by the small shot, yet it would be sufficient. Neither one nor all of them could overcome so many obstacles in the line of flight; but when these obstacles are enemies, each has ample destructiveness. The large shot would do more effective work within the smaller area which it covers, but here again the smaller ones would furnish a compensation for this inferiority; for, while the large shot might go over, fall short, or pass through the enemy without effect, the same contingency must happen to all three of the small ones, which is not so likely, before they all cease to be effective.

The artillery now employed, attempts, and not without considerable success, the double duty of concentrating and distributing projectile matter, to meet the two conditions in which an enemy is found. It does this by the one operation of projecting the large shot which as a shrapnel, or segment shell, shall burst and distribute its fragments, either before or after it shall have done duty in penetrating a defence. The matter is united in one body for the purpose of projection, and then for field use there is an imperfect attempt to subdivide it.

If an imperfect performance of two duties from one mechanical organiza-

tion was better than a division and perfect performance by organizations best adapted to each, possibly the single-shotted gun might supply all military requirements. Brown Bess and smooth-bore field artillery each projected the single shot with considerable success before the rifled musket and rifled artillery were introduced.

The post horse, with no less considerable success, performed the duty of conveyance, doing a variety of double offices and conveniences, more than can now be remembered, which it was clear the locomotive could not, did not, and never has supplied. The fact is, with new attainments with which to compare former results, the latter often dwindle from what was great success to obscure failure. Gunnery furnishes its own illustration of this in comparing the old muskets and the new ones of to-day. The highest performance of the shell occurs when fired from rifled cannon. Being concussive or percussive, it penetrates defensive works as a solid body, and then by its disruption destroys not only such works, but the enemy within them.

The large single shell has here a high military duty to perform, where it has no competitor—of dislodging and uncovering an enemy, and forcing him from what is, on land, a negative condition of power, which has hitherto been, and must continue to be, inferior to the active, mobile, aggressive conditions of attack.

With the shell for field use, for disruption and distribution before meeting resistance, there is only the time fuse; requiring time, distance, and fuse to be accurately measured, and adapted to each other—a practical impossibility. Accordingly, we never know when or where the shell is to be converted into a group of shot; we never know the number or direction of the fragments. Until the bursting of this shell occurs, its efficiency is limited to a trio of small shot, and when the disruption does occur, its trajectory is substantially lost, and all precision and reliability of its action gone.

Assume an enemy to have a depth, vertically, on a plane, or any other surface of 10 feet, and let a shell be exploded into 200 fragments at any point within this enemy; let the fragments have a radial and forward direction, in a front hemisphere. Thus, theoretically perfect in the time, place, subdivision, and direction of the matter, it will be found that but 40 of these 200 parts can remain within the space occupied by the enemy, at the distance of 50 feet from the point of disruption, and at the distance of 100 feet, but 20.* Thus it must be apparent that the fragments of a shell of the same number and weight as the flying cluster cannot cover the hundredth part of the area, and surface, swept by the latter. If the shell has been found efficient in the field, it indicates in my judgment, not that it will be a competitor with the cluster, but the superior effect which may be anticipated from the latter. It must, I apprehend, be conceded, that the gun which will, with the highest efficiency and economy—terms which include everything—subdivide the largest quantity of matter into the greatest number of small deadly parts, and give the highest range and precision to each—the whole forming a group or cluster, best calculated to sweep and cover the ground of the enemy—that such a gun is most valuable for the field.

* This is on the assumption that the radial and projectile velocities are the same.—O.V.

Can we project, say, 163 small shot of the aggregate weight of the 12lb. shot or shell, or say 300 of the aggregate weight of the 20lb shell, under the same conditions as this single shot; that is, from a gun of no greater weight and dimensions, with equal facility for moving, the same ease and rapidity of discharge; these small shot to be solid or percussive shells, each to have a range and precision equal to that of the larger one, of which it is, in this view, a fragment, the whole to form a group, cluster, or swarm, to cover a large area, with a deadly force, *throughout the whole trajectory?* I answer, Yes, with the same ease, simplicity, and facility.

Assuming this answer to be correct, for one moment, before demonstrating it, such a gun may not present analogies which occur in comparing the new musket with the old one, or the locomotive with the horse. Yet, if we are to estimate the relative amount of work done in the same time, with the same physical or organic agents, neither shows a greater contrast than this new system of artillery, compared with that now in use.

We have observed that two modes of projection are theoretically and practically required to meet the two conditions of an enemy: one, the means to assail him when protected by defensive works, either on land or water, which the large single shot and shell gun furnishes; the other, to meet him when uncovered, in the condition of attack. The system which I now make public, is intended to meet the last-named requirement.

Of the comparative dignity and importance of the two systems best calculated to meet these two conditions, a few words may be said. As an enemy is most dangerous when uncovered and aggressive, so, for this reason, both the instinct and logic of man has assumed, the most efficient means of attacking him in this, his most formidable attitude as the highest means of attack and of defence. Indeed, we involuntarily look for the most deadly weapon by which men can destroy each other in the open field, and not without ample cause; for decisive struggles, on which national results depend, will be decided there.

It has been so in the past, it must be so in the future. Nations are not subdued until their country is penetrated, and the invader must be met, before he penetrates to the heart of an empire; thus, by a sort of natural necessity, compelling a proximate equality of naked condition in all great collisions, where an equal consciousness of strength animates both sides. And, whatever may be the conditions of naval warfare, or of coast defence, armies are not likely to march with iron plates before them.

I hope to present physical evidences to the senses, which are so much more potent than words, showing that a large shot, or in other words a large quantity of matter, may be subdivided, and thus simultaneously projected. Yet the senses cannot on this occasion ascertain that each one of these small parts will attain the range and precision of the larger projectile. The understanding can, however, be very well satisfied on this point.

To those who have considered the matter, it will not be new to hear that relatively small shot can be projected with a range and precision substantially the same as that of the relatively large shot. Such is the fact; not, it may be true, under precisely the same conditions, because the small shot can always obtain better conditions for projection than the large one. No doubt there are limits to the subdivision and reduction of projectile

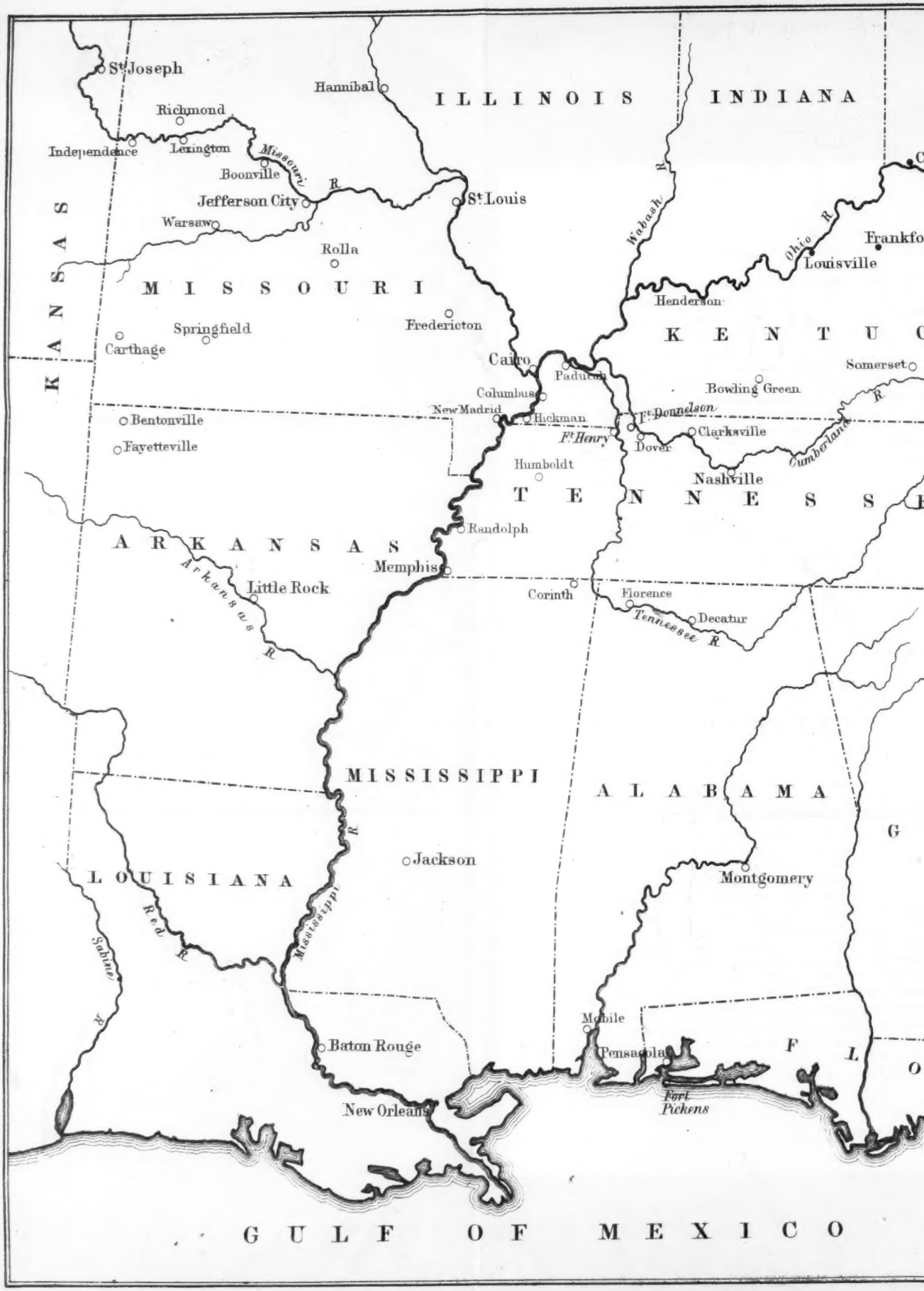
matter (as there is in its aggregation) which, when passed, must impair its effectiveness in range and precision. For it is wholly improbable a fine pin or needle can be projected 9,680 or 10,000 yards by gunpowder. If the 530-grain bullet or even the ounce shot passes below that limit, in my judgment it has yet to be proved. It is not extreme distance of flight that I am considering, although that may be undetermined—it is lowness of trajectory—it is the attainment from an elevation under 10°—it is the range of accuracy, of what we call horizontal fire, which now lies within about 3,000 yards with the best rifled artillery. It is a remarkable fact in this connection both in artillery, and small arms, generally, that as the calibre has been decreased, the range of accuracy has been increased.

As great accuracy at long range has been obtained in this country as any where, from both the small and large shot.

Of Government artillery the service 12-pounder is not surpassed by any larger calibre in these respects; it is the smallest from which I have seen reports. Passing to other makers of artillery, it will be remembered of the noted experiments of Mr. Whitworth, at Southport, with his guns of various calibres, up to an 80-pounder, the greatest accuracy and precision as well as the longest flight of the projectile, 9,680 yards, was from the smallest, a 3-pound projectile, 1½ inches in diameter. Another distinguished producer of artillery, Captain Blakely, has had I believe a like experience, with similar results. If the requirement from either of these three sources should be greatest accuracy at longest distance, I apprehend the calibre selected would be from below, rather than from above, any given standard now used.

To come to my own experience, I have obtained as great accuracy at extreme ranges from an inch calibre and a shot of 10½ ounces as I have seen recorded from the 12-pounder or any larger service gun. Then again I have obtained equally satisfactory results from the ·577 Enfield calibre, with a 2-ounce shot; this last shot, from this bore, giving as low a trajectory and as great precision, at any distance within 3,000 yards, as any service artillery I know of. With small arms we have the "small bore" supassing any of the larger bores which gun-makers produce; and comparing the largest and smallest shot now used for military purposes in this country, the elevation which gives 2,650 yards range to the 100-pound projectile gives 2,000 yards to the smallest shot, from the small-bore Whitworth rifle with 2½ drachms of powder.

Now while, as I have said, the small shot can obtain better conditions for projection than any larger one, it has yet, owing to its superior adaptability, been placed under limitations which the large shot has never been subjected to; these are, that it must submit to be discharged from a gun which a man can easily carry in his hand, with only about one half of its weight serving direct projectile purposes, and which the shoulder shall sustain when discharged. What but these limitations could make the small-bore ·451 superior to the ·577? If not limitations, there must be an inherent superiority of the small bore, and consequently of the small shot, over the larger one, which is more than I claim. By taking the Enfield bore out of a man's hand and away from his shoulder, thus allowing increased projectile matter, increased projectile power, and increased rotary velocity to be applied, it is not inferior to any calibre above,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Louisville
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Springfield
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Carthage
Cairo
Paducah
Somerset
Columbus
Bowling Green
New Madrid
Hickman
Ft Donelson
Cumberland R
Bentonville
Fayetteville
Ft Henry
Dover
Clarksville
Humboldt
Nashville
TENNESSEE
Randolph
ARKANSAS
Memphis
Arkansas R
Little Rock
Corinth
Florence
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Decatur
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Red R
Mississippi R
Montgomery
Sabine R
Mobile
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GULF OF MEXICO

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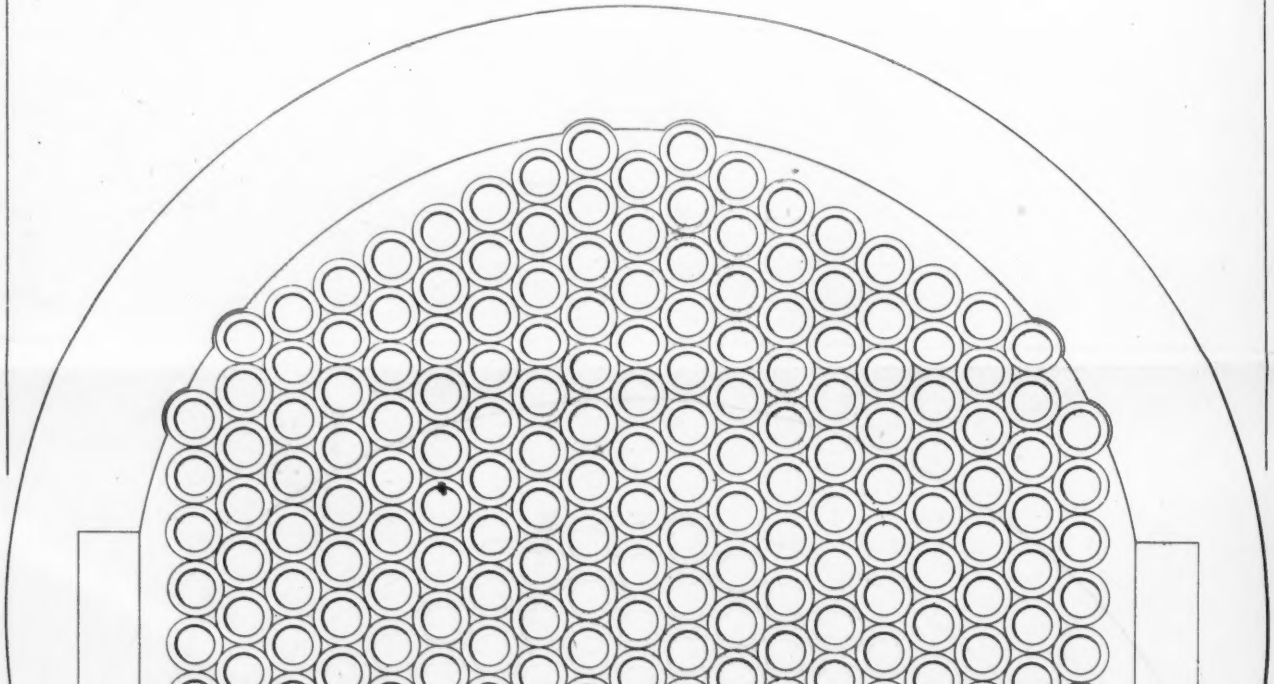
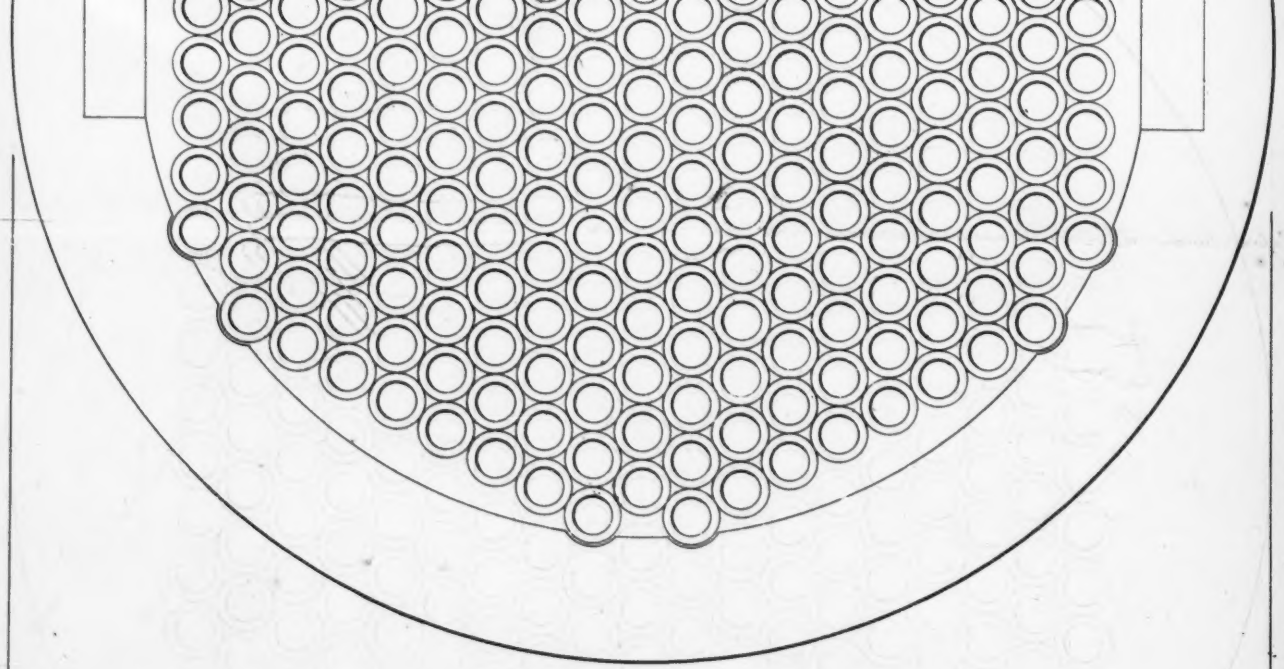
Philippa
WASHINGTON
Beverley
Manassas
Huttonville
Barbourville
Frankfort
Gawley Bridge
Rappahannock R.
Chesapeake Bay
Eastern Virginia
VIRGINIA
Kanawha R.
James R.
Pikeville
RICHMOND
Yorktown
Ft Monroe
Manchester
Somerset
Norfolk
Elizabethtown
Edenton
Windsor
Roanoke I.
Cumberland gap
Raleigh
NORTH CAROLINA
Hatteras
Newbern
Ocracoke Inlet
Beaufort
Fort Macon
Wilmington
SOUTH CAROLINA
Columbia
Milledgeville
Fort Sumter
Charleston
GEORGIA
Beaufort
Port Royal
Ft Pulaski
Savannah
Tybee Island
Brunswick
Fernandina
Jacksonville
St Augustine
FLORIDA
MAP
To Illustrate the First Year's Operations of the
AMERICAN WAR.
1861–2.
Scale of Miles.
100 50 0 100 200.
80 to 1 Inch.

J.R. Jobbins.

GEN^{L} VANDENBURGH'S SYSTEM.

Transverse Section of Gun, with Cluster of 265 Barrels.



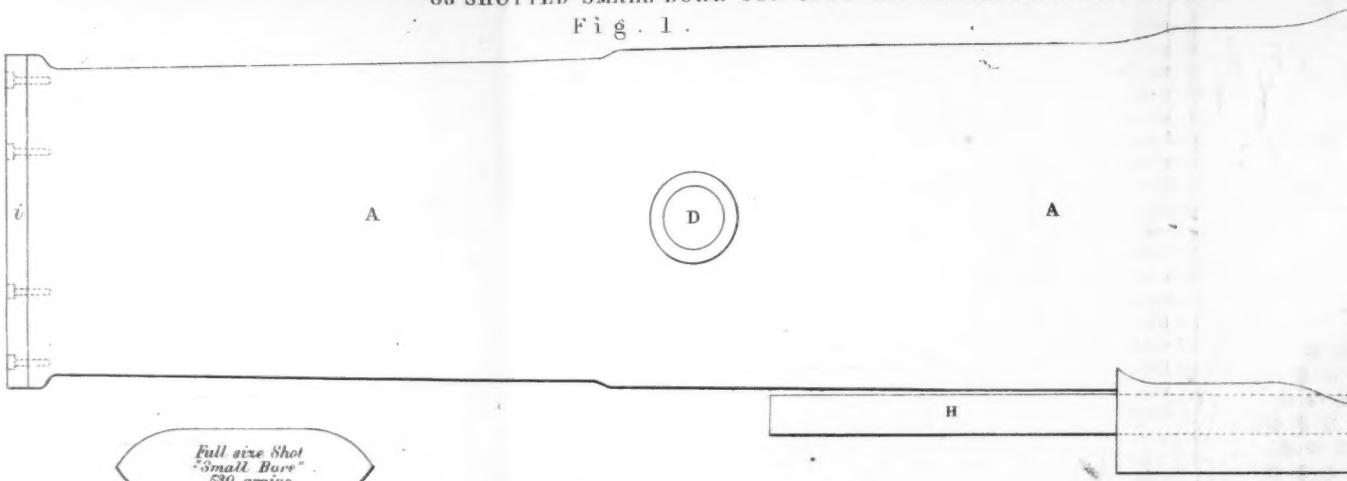


Scale ½ full size.

J.R.Jobbins

85 SHOTTED "SMALL BORE" GUN UPON GEN^{L} VANDENBURGH'S SYSTEM.

Fig. 1.



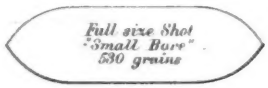
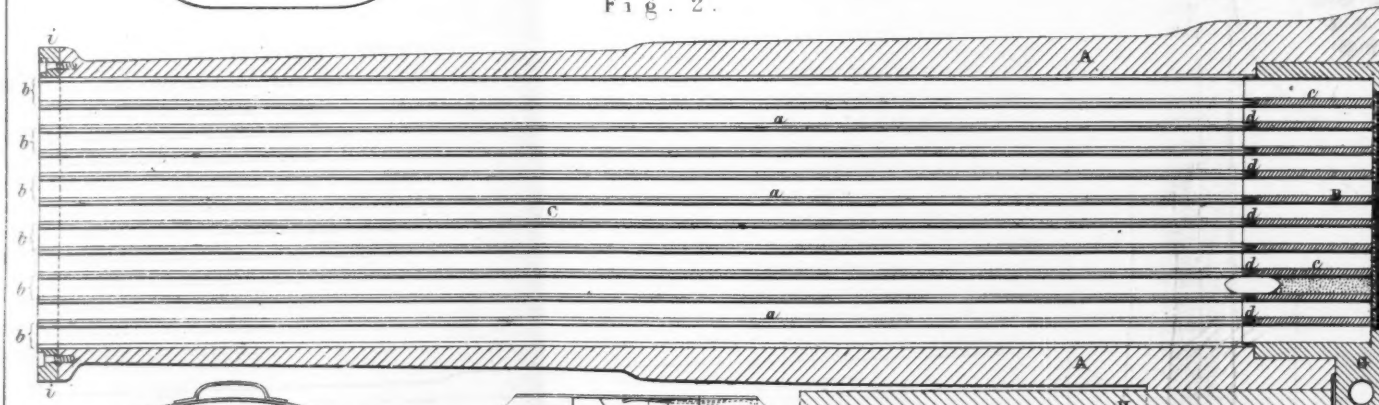


Fig. 2.



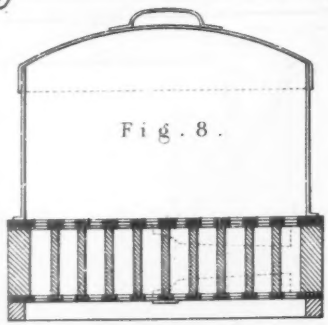
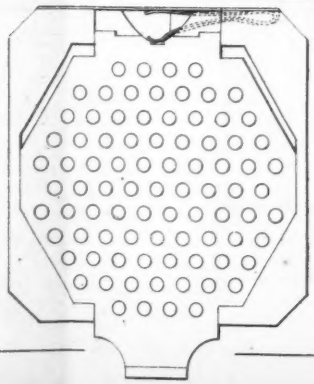


Fig. 8.



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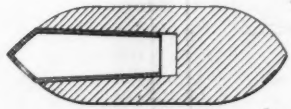


Fig. 11.

Sca

Fig. 3

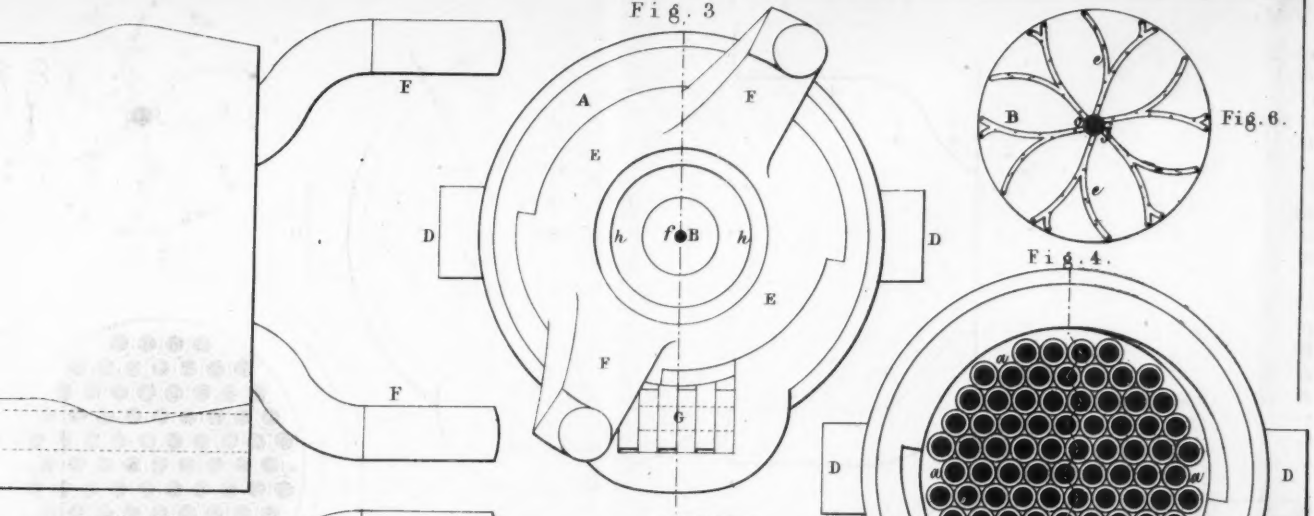


Fig. 6.

Fig. 4.

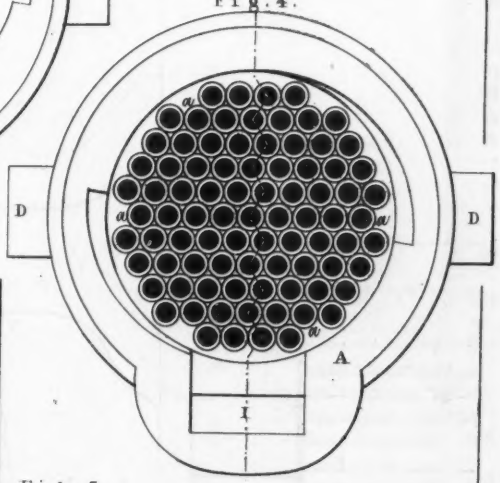
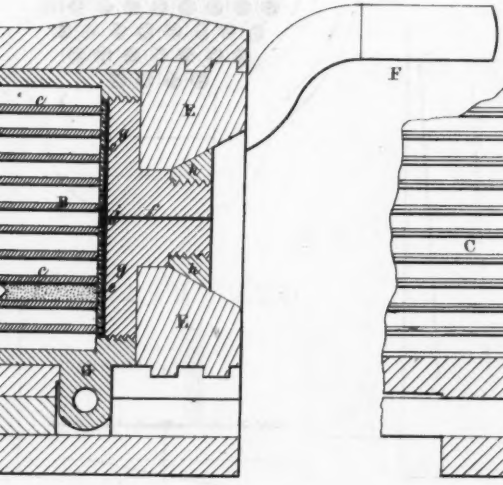
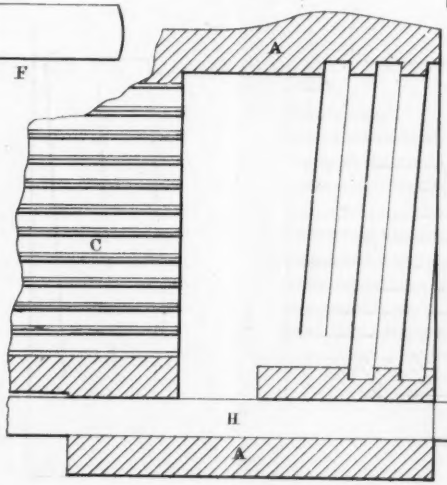
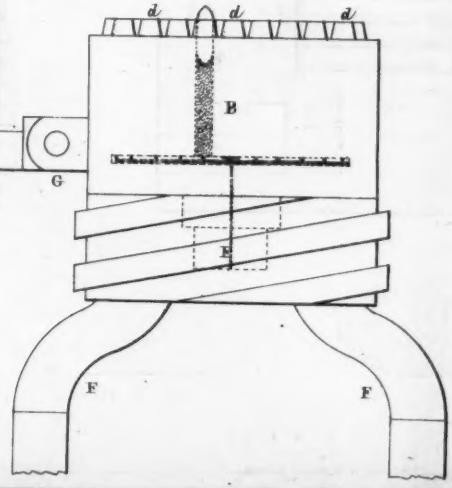


Fig. 5.







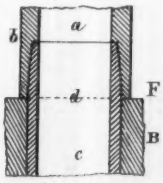


Fig. 7.

Fig. 10.

Scale

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Ft

J.R Johbins.

and greatly surpasses this one below it, in its present condition of use. And what reason is there to assume the ultimate result has been obtained, either from 530 grains of lead or the ·451 bore, in their connection in this musket? What has been obtained from it, has been under these conditions. Before this musket existed, there was the Government charge of 2½ drachms of powder, and of shot 530 grains, which a man stood under; there was the Government musket, with its general form and weight, which were satisfactory. With these, as I infer, arbitrary prescriptions, necessarily imposed it is true, the effort was to obtain the best results. In the combination of these it is a great success.

The Swiss obtain extraordinary results with less than half the weight of lead, and the same quantity of powder. It can hardly be supposed, with proper adaptations in the form of the projectile, and chase, 530 grains of lead can be projected no farther with 5, than with 2½, drachms of powder. All there is of projection, is power applied to, or absorbed by the projectile. No one can pretend the initial velocity of this shot, from this bore, with such a charge as a man can stand and fire, approaches to the ultimate velocity which may be imparted by the power of gunpowder to that weight of matter.

I have yet to make experiments with this small calibre, but you will see we are about to do so. As used it competes in range with the best rifled artillery, and, with these limitations, meets all but the exceptional requirements of the field.

Description of the New System.

The two accompanying illustrative plates will be found to thoroughly elucidate my system of artillery. Plate I. shows a transverse section of a gun, with a cluster of 265 barrels.

Fig. 1, Plate II. represents a side elevation of an 85-barrelled "small bore" gun. Fig. 2, a longitudinal section of ditto. Fig. 3, is a breech, end view, with the breech closed. Fig. 4, is a similar view, with breech-piece and screw removed. Fig. 5. Vertical section of end of gun, with breech-piece carrying screw withdrawn, ready to receive charge. Fig. 6 shows ignition galleries chisel-channelled, with centre charge chamber coming through. Fig. 7. Full-size section showing charge chamber in connection with barrel. Figs. 8 and 9. Side elevation and section of powder charger. Fig. 10 shows full size 2 oz. shot, and 11 ditto with Gen. Jacob's percussive shell.

Throughout this Plate, similar letters refer to the same parts, A being the outside case; B, the breech-piece; C, cluster of barrels; D D, trunnions; E, breech screw; F F, handles for turning ditto; G, hinge attached to sliding bar, H, which moves backwards and forwards in recess I; *a a a*, bores of *b b*, barrels; *c c c*, charge chambers; *d*, short coned tubes set in ends of charge chambers entering breech-ends of barrels; *e e*, ignition galleries cut in a recess in back-face of breech-piece; *f*, vent orifice; *g g*, disc screwing in recess covering ignition galleries. This disc forms a fixed part of the breech-piece, and has a projection upon which the screw E turns; the nut *h* holding breech and screw together; *i*, muzzle plate; and *j*, central point of ignition.

No one but he who is devoted to an art, knows how very little is at any one time added in its progressive developement. Yet no one so well knows that progress is one of its conditions, gaining, as a general rule, step by step, seldom throwing aside as useless or rendering nugatory that which has been of advantage. Addition, he discovers to be the law of advancement, and the addition of a very little, sometimes produces great economies in both the arts of peace and war.

The normal developement of gunnery by this additional process is clear and distinct throughout its whole history to the present time.

In noticing only the latest substantive advancement, the addition of rotatory to the translatory motion of the projectile, it is observed that a high degree of perfection had been attained in the gun for projecting the round shot, from the smooth bore, before a basis was reached, in the form, structure, and material of the gun, for elongating the projectile, and adding rotatory to its direct motion. Nothing of previous attainment was lost, for the rifled not only utilizes, but imperiously exacts each principle, form, structure, and part, of the most perfect smooth-bore gun. This is one of the endless examples which all material progress exhibits of its rigid economy. Revolutionary abandonment and overthrowal of what has been gained, are rare phenomena, in the domains of physical advancement.

In the system of artillery now presented there is nothing new, except what may be embraced in the terms—*combination and addition.*

It is merely a combination of small arms, and artillery, into a distinct organization, giving, it is believed, advantages not possessed by either alone, at the same time preserving and giving free scope to all of realised science and art in gunnery.

The existence, and high developement, of both small arms and ordnance, was an essential precedent to its production.

If it be a normal growth of gunnery, as legitimate as any advance which has been made, and of no less importance, time and use will be sure to demonstrate it.

It is evident that to discharge any given number of shot in a cluster, and utilise the means for giving the highest range and precision to each, there must be employed a number of rifled bores, equal to the number of shot.

The mechanical difficulty of piercing a solid shaft or cylinder with orifices, compared with the cheap and almost perfect production of the single tube or gun-barrel, not only suggested, but practically forced, the adoption of the latter as the basis of the gun. To combine a number of these in a compact form so as to make a single body, to occupy no greater space and to be of no greater weight than the single bore, for projecting the same weight of metal, each to perform its office of projection as perfectly as if alone, was a work of considerable difficulty to attain, though surprisingly simple when accomplished. It was found, on placing a number of externally cylindrical tubes or gun-barrels together, the group was something like the honeycomb in structure with open triangular spaces between them. That each tube had six lines of external contact longitudinally against six surrounding tubes. This contact, even when pressed together, was only a line, scarcely so much as to be called space.

The spring or vibration of iron and steel barrels, when in contact, and

simultaneously discharged, is such as to destroy the range and precision of the shot. It was found, on experiment, that certain alloys of lead, with other metals, even common solder, completely answered the purpose of an *inelastic and deadening lining*, which, by occupying the spaces between the tubes, practically enveloped each although they were in contact (this contact, however, need not, and will not practically occur), with sufficient cohesion to solidify them into one solid body in connection with an outer metallic case in which they were placed. It was then found that not only did each tube perform as well as when singly and alone, but, owing to its being surrounded with this inelastic and incompressible material, with the six adjoining tubes forming so many perfect arches for its support, the barrel, though very thin, was incapable of disruption, and freer from vibration than when in the single gun with an excess of thickness. Each barrel was thus in a more perfect state for projection than has been hitherto practically realised.

In considering the comparative weight of the single barrel of large calibre, and many small ones of the same projectile capacity, it is now well known, (formerly it was doubted,) that the disrupting force of gunpowder increases from an increased quantity, in a higher ratio than the *additional law*, which regulates the quantity. Thus, while its quantity is increased by addition, the power for disruption is augmented by some unknown multiple ratio. So the resistance of iron, steel, or any substance, against this force, does not increase in proportion to its quantity, or, more strictly, it decreases as its thickness increases, because the resisting tenacity or capacity of the different layers of the metal cannot meet or resist the force at the same instant. Thus, it theoretically appears, and I have found it so in practice, with a given weight of metal to be projected, and of powder to project it, a less weight of material is required where the powder and shot are subdivided and projected through several barrels than when exploded and projected in one body through one barrel. I have dwelt upon relative weight because it is most important.

With reference to dimensions, there seems to be theoretically and practically no substantial variance between the group and the single bore; for, while the group has greater diameter and allows an application of the power to a greater sectional area of the projectile matter, there is a corresponding diminution in the length of the chase in the small calibre, so that in external dimensions the two systems are about alike when the outer case is added.

It will be seen, by the drawings exhibited, that the following number of gun-barrels in groups, each having the requisite thickness, can be contained in an outer case which is approximately a circular cylinder, the internal diameters of which are given, viz.:

Small bore ·451 calibre, 530 grains solid shot.

No. of Barrels.	Case, Internal Diameter.	Projectile Charge.
85	under 7 inches	lbs. 5·87
151	" $9\frac{3}{16}$ "	" 10·42
163	" $9\frac{1}{8}$ "	" 11·25
211	" $11\frac{1}{4}$ "	" 14·56
265	" 12 "	" 17·66
451	" $15\frac{5}{8}$ "	" 31·11

Enfield ·577 calibre, 2oz. solid shot.

No. of Barrels.	Case, Internal Diameter.	Projectile Charge.
85	under 8 $\frac{7}{8}$ inches	lbs. 10·62
151	„ 11 $\frac{3}{4}$ „	„ 18·87
163	„ 12 „	„ 20·37
211	„ 15 $\frac{1}{4}$ „	„ 26·37

The addition of the Case with trunnions, of from one to two and a half inches in thickness at the breech, decreasing to one-fourth of an inch at the muzzle, shows the full dimensions of the several guns, of different capacities.

Having thus obtained a group of barrels, which in weight, form, and facility of mobilising as a single body, will compare, in these respects, with the single bore of like capacity, the next step is, to prepare for charging, and discharging them, with equal facility and rapidity.

Breech-loading may have limits in its economy with the single shot, possibly very narrow limits; applied to the multi-barrelled gun, it surpasses the most sanguine anticipations of its projectors.

A solid block, or disc of metal, is bored with as many orifices, or chambers, in its front face, as there are barrels, each to hold the required quantity of powder for each shot, as well as the shot. They correspond to the group of bores, so that when this disc or Breech-Piece is brought against the breech-ends of the barrels, it gives a separate charge-chamber or breech to each.

If, in bringing this breech-piece against the barrels, or, in other words, the charge-chambers, in connection with the bores, this union should be in any degree imperfect, the escape of gas, or windage, from so great a number in such close proximity, would at once disrupt, or ultimately destroy the gun.

The revolving fire-arms of Colt, Adams, and others, it is true, show a chamber behind the barrel, dependent only upon the mechanical fit of two plane surfaces to stay windage; but here there is but one chamber, and the gas, if it escapes, passes harmlessly into the atmosphere. Again, with one barrel, a close mechanical fit can be obtained, while it is impossible to bring several hundred, against a plane surface, so that each will equally fit, and press against it.

It was found if short thin Tubes of copper, brass, or steel (when of the latter material to be rolled in two thicknesses, like a strip of paper which has been coiled about the finger,) projected a short distance, say one-third or one-half an inch, from the powder-chambers in this breech, so as to enter a recess larger than the bore in the breech-end of the barrels, they formed tubular bridges over this joint or union, and the escape of gas was stopped. For, however loose is the fit of this tube in the barrel, if it is thin, or made of a coil so as to be elastic, the expanding gas in passing through, presses it outwards against the surrounding chamber, thus making for the time, when it is required, the most perfect mechanical fit. By making these short tubes conical, that is externally tapering, and thinner towards their projecting ends, it insures their easy and safe entry, and allows the breech-piece to be pushed, or brought home against the group, without the application of any considerable force to the breech-screw.

Here then is obtained a moveable breech, capable of receiving the powder and shot in separate charges, and when in position behind the group of barrels, and retained by a screw working behind it, making separate and perfect guns of each, as independent as if there was but one barrel and one breech-piece for it. Like the barrels, these chambers are in a single piece, to be manipulated with the same ease and facility as though it contained one charge chamber, which would hold the same quantity of charging material.

We now have bores and breeches, in which the highest proportion of powder may be applied to each shot; for this architecture of the honeycomb, and surrounding arches, extends to the breech-piece as well as the barrels, giving the greatest possible resistance to the quantity of metal employed.

For producing simultaneous ignition, it was observed that radiation was nature's process of distribution; that heat, and the gas from gunpowder, which contains it, are both imbued with a radiating tendency, as one of their primal laws of being.

A central point of ignition with galleries radiating from it, in the breech-piece, in the rear of the powder chambers, forming arteries or flues, and connected with the chambers, by no matter how small an orifice to each, was found to produce simultaneous ignition in an admirable, and nearly perfect, manner. Gunpowder, when confined so as to exert great force, has a tendency to remove obstructions, and, where there is a passage or vent, to open and not to close it. These passages do not receive the powder but only its gas, and require cleaning only at long intervals, and after hundreds of discharges. They are either bored with a drill in the solid rear of the breech-piece laterally or crosswise, or, which is preferable, cut in the form of channels with a chisel on the back face of the breech, and small orifices pierced from these channels to each chamber. This face is then covered with a flat disc which is brazed or screwed over them. While the latter process is most economical, it also allows curves to be introduced in the place of sharp angles at the various points of intersection, which angles are objectionable in the boring process.

The drawings exhibit the position of these galleries and the simple arrangement for easy access to them, when required.

A vent orifice, in the centre of the disc in the rear, leads to the centre of ignition and radiation, in which a friction-match may be inserted, or to which a lock and cap may be applied, thus again using the same arrangements for discharging the gun found most convenient with existing artillery. The centre charge chamber, if bored deeper than the others, will come down into and drop part of its powder charge in this focal centre of the ignition galleries. This is a convenient arrangement, as it supplies the ignition powder, without any priming or especially prepared match, to give the requisite gas for the galleries. The outer case, on which are the trunnions, extends in the form of a hollow cylinder to the rear of the barrels, for the reception of the breech-piece, and also so much further to the rear as to allow a screw or plate, turning on a pivot or boss projecting from the back side of the breech-piece, to screw into this hollow cylinder. This screw serves to open and close the breech and hold it in position during the discharge. There is a hinge joint which connects the lower side of the breech-

piece (when the gun is relatively small) to a sliding bar, working in a groove, in the under side of the case. When the breech is unscrewed it opens or falls back like the lid of a teapot, supported by this hinge and bar. The front face of the breech-piece is thus in a horizontal position with its charge chambers opening upwards ready to receive the charge. When the gun and breech-piece are relatively large and heavy, instead of one sliding bar at the bottom, there should be two, one at each side, and instead of a hinge the breech is attached by small pinions, so that it will swing or hang between them when unscrewed. Such is the gun. It consists of but three parts, not counting the hinge bar; with this, four; and when two of these, five. The outer case, with a female screw in its inner periphery at the breech end, its trunnions, its muzzle-plate, and its cluster of barrels solidified inside, forms *one*. The breech-piece, with its chambers and short tubes on its face, its galleries, and vent orifice, *two*. The screw, with two short handles working behind the breech-piece, *three*.

It may be noticed by the thin and extended circumference of the case at the breech, greater surface for the thread of the screw, and consequently greater strength, is afforded from the same weight of metal than in the single bore system. The screw can only receive a direct back pressure from the attempted recoil of the breech-piece, there being no lateral or bursting strain upon it, and it is wholly removed from the powder. Again, subdividing the powder gives less strain in this one direction, while the cutting or bursting effort of the gas for escape, is limited to its force in any single chamber.

Now, can the same principle of combination be used in introducing the powder and shot into the gun? I answer, Precisely the same.

The operation of charging is extremely simple, and performed as quickly as the charging of a musket. In all cases, the gun can be charged as rapidly as any single-shotted breech-loading guns projecting equal weights of metal. A charge, though made up of many parts, is handled as a single united body.

The same time and effort is required to empty a given quantity of powder out of one large measure, as from several hundred smaller measures, when the latter are connected together so as to be controlled by one act.

There is the same care and precision required to bring one bullet coincident to an orifice for insertion, as in bringing 200, when the latter are so arranged that, when one is in the right position all the others must be.

While a cartridge can be made for inserting the powder and shot together, conforming with the existing practice of putting in the powder at one operation and the shot by another, is considered, as at present, satisfactory.

For charging the powder, I use a Brass Flask with a flat bottom, of the same dimensions as the face of the breech. A slight rim or band around the bottom serves as a guide, so that it will always and instantly take a definite position when set on the breech-piece. It may conveniently hold but one whole charge, or 3, 5, 8, or 10, depending upon its upward extension, upon the capacity of the gun, and upon what may be found most convenient in this respect. The top is covered with a lid, so that a package of powder can be instantly put in and closed. The bottom is

pierced with orifices, corresponding to the charge chambers. Inside, there is a separate compartment over each of these orifices, each of which will contain a precisely measured charge, all alike. The powder in the flask is above these compartments.

Now, by the simplest possible arrangement of two plates with holes in them, one above and one below in the inside of this flask, controlled by two knobs or springs on the outside, and by merely touching these with the finger the compartments are instantly filled and instantly emptied. At any time, whether on the breech or when held in the hand, or in the act of setting it on the breech, the pressure of the finger opens the compartments above, and the powder falls in and fills them. By placing this flask upon the breech-piece and touching a spring, there is instantly deposited in each chamber a measured charge.

Whether the breech contains one chamber or 500, charging with powder, by this arrangement, will be the same both in time and manipulation. This charger is strong and compact; when the lid is closed it is a sealed case; neither wind nor weather, indeed neither water nor fire, unless from a shell striking it, can impair its use. In charging the shot, that form of projectile most perfect for projection is found most convenient. By loading at the breech, the shot are deposited in chambers slightly larger in diameter than the chase or bore. They thus take the rifling without being expanded, which in muzzle-loading is obtained by the flat end and hollow rear. An elongated projectile, conical at both ends, is used. These are set in orifices, in discs of common deal, corresponding to the chambers in the breech, with the usual paper patch around them. These orifices are slightly opened or countersunk on the underside of the disc, so that when placed on the breech, the ends of the short tubes will just enter each, and give it a definite position, with the orifices which contain the bullets directly over the chambers. When the shot are set up in these discs, melted beeswax and tallow is poured upon them; this in its fluid state surrounds the shot in the orifices, and in cooling, hardens and retains them in their places. They are now in the most perfect form and condition, cheaply packed in discs ready for use and transportation. If each shot contains one of General Jacob's percussive shells, they are by this arrangement handled and put in the gun with perfect safety, and I cannot see why they may not be securely stored and transported in this way.

To charge the shot, one of these discs is placed on the breech, and by the application of a flat board with projections, like the ends of ramrods, on its under side, about an inch in length, they are instantly pushed through on the top of the powder. More force but less time is required to push 100 to their places, than one through the barrel of a muzzle-loading rifle; as a ramrod with two points upon it can be carried one inch and back, quicker than one point can be carried 30 inches and back again. By taking hold of the handles of the screw, the breech is turned up and slid forward, when the screw catches in the case; one turn of the screw (one hand of a man has ample strength for this with a 12-pounder) and the gun is ready for the match.

Another convenient means of loading the shot is to put them in deal discs with their front ends at the bottom, the orifices in which they are set not being pierced through the board. In this case they are not

fastened by the lubricating material, but set loosely. A mahogany or other hard wood board and a brass plate fastened to it, with holes through them, corresponding to the cluster and breech, is all that is now required as a bullet charger.

A spring keeps the brass plate with its lands or solid parts under the orifices in the board, so that the shot cannot pass through. This charger is set on the disc containing the bullets and turned over when they fall into the holes in the charge-board. It is now placed on the breech; guides give it the right position; when, by touching the spring, the holes in the brass plate are brought coincident to those containing the shot, and the latter instantly fall through into the breech.

My experience as to the divergence of the shot, or density of the cluster when discharged is this:—Commencing first with a 37-barrelled gun, bores one inch in diameter, set parallel, shot 10½ oz. each. The gun is under 900lbs. in weight, capacity over a 20-pounder. The arrangements connected with the breech were less perfect owing to the early stage of the invention, than those now exhibited. I may say its power and endurance were surprising. The only injury I could inflict upon the barrels from any weight of charge occurred at the muzzle, where, from the rapidity of twist in the rifling, extreme length 50 inches, and high velocity of the projectile, high charges had a tendency to tear out the bores towards the muzzle. The mechanical defects or want of perfect parallelism in the bores gave the shot a divergence of some 25 feet in 400 yards; at 200 yards, the divergence was only half this, and at 800 yards, twice as much, and so on to any distance, which I could ascertain and measure. And this is a condition of the system, a diverging cluster increasing in proportion to the distance, and plan of divergence adopted in the structure of the gun. Where the group exceeds 150, I apprehend a slight divergence or opening of the barrels at the muzzle either horizontally or vertically, or both, will be desirable. In a gun of 91 barrels, Enfield ·577 bore, set parallel, I find about the same divergence in the shot as that just described. Thus, at 100 yards nine-tenths of the shot will be placed in a target six feet square, though it takes a target nine feet square to take them all at this distance, owing to the greater divergence of a few. At double this distance they occupy twice the space, and so up to a mile when they cover substantially about 100 feet. When only one-half or one-third of the group in this 91-barrelled gun are discharged they yet give about the same divergence, so that I infer when the barrels are set parallel, the mechanical defects do not increase the spread of the shot, when there are a great number, more than when there are but few. Theoretically this would be so, and I have found it so in practice. It would follow when a gun projected 200 or 300 shot, there would be a great density even at an extreme range of 2,500 yards, if set parallel. At 1,200 or 1,500 yards they would cover a breadth of 65 or 75 ft. so effectually that not a man could live on the ground swept by such a cloud of shot.

For a handy field gun, 150 of the "small bores" can be made to come under 600 lbs. in weight; its capacity will be 10½ lbs of shot. Recoil, by the sub-division of powder and shot is reduced to meet this reduction in weight.

I can see no cause why these guns will not stand the wear of service as

well as any others. A small rifled shot wears the chase less, and a small charge of powder eats out a breech-chamber less than when the shot and powder are increased.

The only parts which can be considered delicate and liable to injury by use, are the short coned tubes on the face of the breech. These from the manner of charging cannot well be injured; but, assume it to happen, they cost about two pence each, are set in smooth recesses of very little depth, and, while it is impossible for them to be blown out, they can be instantly pulled out with an instrument if injured, and new ones replaced.

The limits assigned to this paper preclude a comparison of the effectiveness of a given number of shot, projected by a gun on this system, and by the same number of riflemen. I think it can be demonstrated that those from this gun would be by far the most efficient, owing to the great concentration of fire, certainty of aim, and greatly extended range. The various military uses to which these guns may be applied, as well as the advantages I attach to a group of shot, the divergence of which increases with the distance, must from the same cause be left unnoticed.

NOTE.—The latter part of the foregoing paper, descriptive of the system of construction, was delivered without written notes. The breech-parts of two guns, from a 91-barrelled, Enfield calibre, and an 85-barrelled small bore, were exhibited with wooden models and diagrams to explain their construction.

A reference to one feature of construction was accidentally omitted. It is hoped it will not be considered irregular to add it here.

By a simple arrangement, these guns may be discharged by sections of one-sixth, one-third, or one-half of the group, the other sections remaining charged, ready to be fired instantly, or at any interval of time afterwards.

It will be observed the ignition-galleries in any group, however numerous, are but six, as they commence divergence from the centre. By putting a cut-off or stopcock across each of these passages, which, by turning in one direction, will open, and in the opposite close the passage, the gun can be discharged by sections.

With a 30-pounder naval gun, projecting 450 shot, it may be very desirable at times to discharge it in sections of 75 each, in rapid succession.

I have practically tested such a cut-off, and find it can be successfully worked.—O. V.

The CHAIRMAN:—It is not customary at our afternoon lectures to raise any discussions, but this is a most important subject, and, as General Vandenburgh is a stranger, it will probably forward the object we have in view if any gentleman would put any question which would elicit additional information.

Captain BLAKELY: I think that there is no question remaining to be answered, General Vandenburgh has been so lucid in his explanations. If, however, I am not out of order, I should like to express an opinion on the matter. In the first place I will begin with a point in which I cannot go quite so far as General Vandenburgh. That is, with respect to the relative range and accuracy of some of the large guns. I think the larger they are, the more accurate they are. But I do not think that at all detracts from what I perceive to be the great merit of this system, though it will not be applicable for a range of 10,000 yards, yet I believe that up to 2,000, even to 2,500 yards, this system as developed by General Vandenburgh will be effective; indeed, I believe he will be able to carry the largest canister firing up to fully 3,000 yards. We know that General Jacob made very good practice from the shoulder as far as 2,000 yards with a single rifle bullet. Now to fire from a steady rest a cluster of bullets of that kind directed against a battery of artillery at two or three thousand yards must, I conceive, be most mischievous to the battery. At a shorter range perhaps the ordinary canister will compete with it; but for intermediate

ranges, between 500 and 2,000 yards, I can conceive nothing much more deadly. There is one application of it which General Vandenburgh did not dwell upon, and that is against iron-clad ships. Even supposing General Vandenburgh does not overcome the difficulty of loading, which by some simple arrangement so far as I can see he has overcome, yet were that difficulty of loading still to exist, guns of this kind can be loaded at leisure, taken up alongside within range of the iron-clad vessel and fired at least once or twice at the port-holes. I can conceive the possibility of at least two or three port-holes being entered by the bullets, and the certainty of one or two men at each port-hole being killed; and I fancy that would be very much more mischievous to iron-plated ships than even the penetration of one 300-pounder shot. One 300-pounder shot will not stop a ship, and will at most only do very little damage, whereas firing from this gun if continued would really stop a ship.

Captain BURGESS: What would be the weight of one of these guns with the cluster of 85 barrels?

General VANDENBURGH: This gun will weigh about 400lb. The quantity of matter it projects, 85 shots, would weigh something like 6lb. The weight of the gun will be under 400lb; it would depend very much upon how much the outer case was turned down. I find I have over-estimated the strength required. Here is a drawing of a gun (showing it). I do not know that it will ever be made, but I think I could make it entirely successful to discharge 451 of these small shot. I am more and more convinced that these small shot will meet all the requirements of the field. Here is a 20-pounder gun, for 163 shot of two ounces each ·577 bore. The weight of this gun will be 1,200 lb.

Captain BURGESS: Do you suppose that if a 12-pounder shot were to strike that gun, the blow would interfere very much with the barrels?

General VANDENBURGH: I do not know what gun would stand being hit a great many times with solid shot.

Captain BURGESS: I mean if struck by a single shot.

General VANDENBURGH: I think it would injure it. The gun is more vulnerable than existing artillery, less vulnerable than a musket. I do not think it would be worth much after being struck by a 12-pounder shot.

Captain BURGESS: Might it not be obviated by a casing of wrought iron?

General VANDENBURGH: I do not think we have any field-guns that are invulnerable. If they are once hit, or knocked off the gun-carriage, they are worthless for that battle.

Captain BURGESS: The question I ask is, whether, if a shot struck it and bent some of the barrels, it would be useless afterwards.

General VANDENBURGH: I admit that to be so.

The CHAIRMAN: The casing will be iron?

General VANDENBURGH: Gun-metal casing; however it can be made of forged iron or steel. I find gun-metal, as it can be cast in the requisite shape, can be used most conveniently.

The CHAIRMAN: It only devolves upon me to convey to General Vandenburgh our thanks for the very lucid account he has given us of this gun.

Evening Meeting.

Monday, April 7th, 1862.

CAPTAIN R. COLLINSON, R.N., C.B., in the Chair.

Names of Members who joined the Institution between the 17th February and 7th April, 1862.

Life.

Haworth, R. B., Lt.-Col. 22d East York Art. Volunteers, 9*l.*
Jones, O., Capt. R.N. 9*l.*
Marshall, W., Dep.-Lt. Cumb. M.P. 9*l.*
Poore, R. Major 8th Hussars, 9*l.*
Stirling, C., Comr. R.N. 9*l.*

Annual.

Adams, C. Major, Professor R.M. Coll. 1*l.*
Campbell, C. A. Comr. R.N.
Campbell, W. M. T. Lieut. R.E. 1*l.*
Childs, J., Capt. 4th Midx. Rifle Vols. 1*l.*
Chisholm, A. B., Lt. 1st Batt. 25th Reg. 1*l.*
Corballis, J. B., Lt. 1st Batt. 10th Reg. 1*l.*
De Wahl, T. A., Comr. R.N. 1*l.*
Doherty, D. H., Lieut. 3rd Hussars, 1*l.*
Falls, J., Paymr. 2nd Batt. 8th King's.
Fitzgerald, H.L., Cap. 2 Bat. 13th Lt. In. 1*l.*
Forbes, F. C., Lieut. 37th Regt. 1*l.*
Fox, M., Comr. R.N. 1*l.*
Gardner, G. H., Capt. R.N. 1*l.*
George, C., Master R.N. 1*l.*
Hartman, G. A. Cap. 2 Bat. 13th Lt. Inf. 1*l.*
Mann, W. A., Major late Kent. Mil. 1*l.*
Philips, G., Lieut. 2d Batt. 2d Queen's, 1*l.*
Peto, W. L., Major 2d Bat. 13th Lt. Inf. 1*l.*
Pennefather, R. P., Lt. H.M. Mad. Eng. 1*l.*
Russell, L., Capt. H.M. Beng. Eng. 1*l.*
Rowcroft, H. C., Lt. H.M. Beng. Eng.
Rawlins, S. W. Lieut. 8th Hussars, 1*l.*
St. Clair, C. W. Major 57th Regt. 1*l.*
Sitwell, H. C., Lt. H.M. 5th Ben. Lt. Cav. 1*l.*
Smith, A. C., Capt. 1st Batt. 25th Regt. 1*l.*
Sotheby, F. E., Capt. Rifle Brigade, 1*l.*
Trousdell, W. G., Surgeon 2nd Batt. 13th Lt. Inf. 1*l.*
Whitla, W., Lieut. 1st Batt. 10th Regt. 1*l.*
Young, C. F., Major R.A. 1*l.*

ON THE DISEMBARCATION OF TROOPS.

By CAPTAIN W. R. MENDS, R.N., C.B.,
DIRECTOR OF TRANSPORTS.

BEFORE I enter upon the subject standing on the paper in my name for this evening, I must ask the indulgence of the meeting for a few moments whilst I endeavour to explain how it is, that, for the first time in my life, I find myself in the position of lecturer, and before so critical an audience. It being generally known that I am the officer who drew up the arrangements for conveying to, and disembarking the British expeditionary army on, the shores of the Crimea, as well as for the subsequent minor operations at

Kertch and Kinburn, I have at various times been appealed to for some of the details connected with those undertakings, in order that the experiences then gained might be turned to account. In 1858, at the request of the officer who was entrusted with the task of compiling the engineering data of the Crimean operations by the Topographical Department of the War Office, I furnished a paper of the programme, a copy of which is on the table.

About five months since I was again appealed to by a brother officer to read a paper at this Institution on "The Disembarcation of Troops," as the subject was deemed important. To deny its importance was impossible, and that I should deliver a lecture upon it seemed equally impossible; therefore, on the moment, I declined to undertake it; notwithstanding which, I am here to-night to claim your indulgent hearing of nothing abstruse, theoretical, or amusing, but merely a few facts and opinions, the result of personal experience, in the hope that they may prove so far useful as to call attention to an important professional subject.

I adopt as my motto a quotation from Cicero—

"Qui mari potitur eum rerum potiri;"

which is translated thus:—"Whoever is master of the sea will possess the empire." And Bacon comments upon this as follows:—"But thus much is certain, that he that commands the sea is at great liberty, and may take as much or as little of the war as he will; whereas those that be strongest by land are many times nevertheless in great straits. Surely at this day, with us of Europe, the 'vantage ground of strength at sea (which is one of the principal dowries of this kingdom of Great Britain) is great."

England will do well if she lay to heart in 1862 those remarkable sentences.

My subject then being the disembarcation of troops, I set out with the belief I entertain, that to a great military nation possessing supremacy at sea belongs the power of successfully landing a large army on the shores of any other nation with which she may be at war, and that on the sea alone can an attempt at invasion be frustrated.

In support of this assertion, I purpose first directing your attention to some of the remarkable expeditions recorded in history, coming down to those nearer to, and in connection with, our own times. Secondly, I shall make a few remarks on the disembarcation of an army, showing on what contingencies we must depend for the success of the operation. Thirdly, I shall speak of the duties of the seaman towards the soldier when embarked. Fourthly, I shall put before you the elements composing an army, with a few observations on each. Fifthly, I shall direct your attention to the necessity for adapting the vessel to the arm of the service she has to carry, or, *vice versâ*, the arm to the vessel, with a view to rapid disembarcation; also to the description of boat or raft for commodious, safe, and expeditious landing. And, lastly, I shall give the details in connection with an imaginary landing of an army.

Ancient history tells us of many combined naval and military operations, some of them of so gigantic a character, in point of number of men, as compared with those of modern times, that we are almost apt to question the veracity of the historian. For the conduct of those expeditions by sea (however short the distance), the arrangements must have

been very perfect or they would have broken down under the pressure of mere numbers.

The expedition of the Argonauts, undertaken 1263 B.C., was of an important character, carried across that capricious Black Sea which absorbed the attention of the world in 1854 A.D. We read that "this was the first great enterprise of the Greeks. This is supposed to have been both a military and mercantile adventure, and was singularly bold for the times in which it was undertaken. The armament consisted of many ships, of which Argo was the largest, equal to a modern vessel of 200 tons burthen. The astronomer Chiron directed the plan of the voyage;" which I take to mean that the seamen of those days wisely looked to Chiron, as we in this age should look to Fitzroy, to whom the merchant and seamen owe a vast debt of gratitude, which will probably be more largely acknowledged by the next generation.

"481 B.C. Xerxes' army, after crossing the Hellespont, numbered 1,700,000 infantry and 82,000 cavalry. In the fleet were 1,027 ships of war and 3,000 galleys of three banks, having on board 517,600 persons." The passage of such a host across such a stream as the Hellespont required great administrative and practical ability. Further, we read that with 1,200 ships he attacked 380 Greek ships in the Bay of Salamis, and on being defeated Xerxes fled with precipitation across the Hellespont, as I conclude his supplies were cut off.

The expeditions of Alexander the Great are without end: 334 B.C. he crossed the Hellespont with 30,000 foot and 5,000 horse, encountered on the banks of the Granicus the Persian army of 100,000 foot and 10,000 horse, and defeated them. The operation of crossing must have been expeditious and precise, the result alone of good arrangement. Alexander's admiral, Nearchus, must have possessed infinite ability and nautical skill in the conduct of his fleet, embarking, disembarking, and supplying armies in the Indian seas.

The successful invasion of Britain by Julius Cæsar 54 B.C., and again by William of Normandy in 1066 A.D., were well-executed operations, showing great nautical skill and arrangement.

We read, in a paper by Professor Airey, of the former, "that 600 ships adapted to beach-landing were built expressly for this expedition, 28 long ships and numerous merchant vessels, so that 800 ships were in sight at once, carrying five legions, or 21,000 foot and 2,000 cavalry, besides camp followers and sailors, probably 40,000 souls in all." This flotilla was floated off at a single tide from some port of France. I conclude the characteristics of the British Channel have not much changed.

The same author tells us that William floated at one tide 1,400 ships, carrying 60,000 men.

The Spanish Armada, which threatened this country, was defeated at sea by a comparatively small but gallant force, the elements certainly proving adverse to Spain.

In the year 1647 the Dutch Fleet, with but 4,000 troops on board, alarmed the whole coast of France, and by it obliged the French king to keep near 100,000 men upon the maritime coast, as not knowing what point they would fix on. A state of things to which the following

quotation from Dryden's satire, entitled Absalom and Ahitophel, seems appropriate:—

> As when a battling storm, engender'd high,
> By winds upheld, hangs hov'ring in the sky,
> Is gaz'd upon by ev'ry trembling swain,
> This for his vineyard fears, and that his grain;
> For blooming plants, and flowers new opening, these,
> For lambs yean'd lately, and for lab'ring bees:
> To guard his stock each to the gods does call,
> Uncertain when the fire-charg'd clouds will fall;
> E'en so the doubtful nations watch his arms,
> With terror each expecting his alarms.

It may be said that we should not and cannot well compare the expeditions of bygone days with those of the present age; but I confess I do not see why. In my opinion, invasions or disembarcations are as practicable now as they ever were; indeed, navigation has been simplified by the aid of steam, and operations proportionally accelerated. An insular nation like our own should never permit a hostile force to reach her shores.

Look at the remarkable and successful landing of troops at Cape Breton in 1758 under Admiral Boscawen and General Amherst. We read in "The Conquest of Canada," by that charming writer Warburton, the graphic description of that operation, as follows:—

"Equipments were carried on in England with vigorous zeal, and on the 19th February, 1758, a magnificent armament sailed from Portsmouth for the Acadian peninsula. It reached Halifax on the 28th May. [three-and-a-half months at sea! Imagine the horror-stricken mind of the present day at such a voyage.] 22 ships of the line, 15 frigates, 120 smaller vessels, sailed under the Admiral's flag, carrying 11,600 troops, including artillery and engineers, almost exclusively British regulars. The troops were told off in three brigades of nearly equal strength under Brigadiers Whitmore, Lawrence, and Wolfe.

"At dawn, on the 2nd June, the armament arrived off Cape Breton, where the greatest part of the fleet came to anchor in the open roadstead of Gabarus Bay."

It was evident that celerity and precision were the order of the day, accompanied by complete preparation and organisation; for mark what follows:—

"Amherst, the General, hoped to land before daylight and surprise the garrison of Louisburg; and, with that view, orders were issued to forbid the slightest noise, or the exhibition of any light, on board the transports near the shore; the troops were especially warned to preserve profound silence as they landed. But the elements rendered these judicious orders of no avail. Morning came with a dense fog and heavy Atlantic swell, which broke in impassable surf on the beach. This lasted for six successive days, during which the enemy toiled night and day to strengthen their position ALONG THE BEACH, and lost no apportunity of firing upon and shelling the ships. On the 8th the swell partially subsided, and the naval officer, Commodore Durell, pronounced the beach practicable. The troops were placed in the boats before daybreak; the inshore covering ships opened fire to clear the way; in a quarter-of-an-hour the boats pushed on, the left under Wolfe, the right and centre under Whitmore and Lawrence. The left division was the first to reach the beach. The French stood firm

and held their fire until the assailants were close inshore; then, as the boats rose on the dangerous surf, they poured in a rattling volley from every gun and musket that would bear. Many were struck down, but not a shot returned. Wolfe's flagstaff was shivered by a bar-shot, and many boats were badly damaged; still the sailors forced their way through the surging waves, and in a very few minutes the whole division was ashore, and the enemy driven from their entrenchments. The victors pushed on, making 70 prisoners, until the guns of Louisburg checked their advance. In the meantime the remaining British divisions had landed, but not without losing 100 boats and many men from the increasing violence of the sea. For two more days no artillery could be landed. On the 11th the weather began to clear and progress was made. Hitherto the troops had suffered much for want of provisions and tents. On the 26th Louisburg surrendered."

I can scarcely quote a stronger example in proof of my belief that it is always in the power of a great and gallant people, with God's help, possessing command of the highway the sea, to conduct a flotilla and land troops on a hostile shore in safety. The resistance offered was gallant,—the characteristic of French troops.

The landing of Wolfe at Quebec in the subsequent year sounds almost like a romance.

The landing in Egypt under Admiral Lord Keith and Sir Ralph Abercromby is another striking case.

"On the day of arrival in Aboukir Bay, too much time elapsed before all were at an anchor to allow of the disembarcation being accomplished before night. For six successive days, northerly gales with a heavy sea prevented the operation. At 2 a.m. the troops began embarking in the boats, numbering 320. At 3 a.m. the signal was made to rendezvous near a brig of war at anchor, at gun-shot distance from the shore; but so great was the range or extent of the anchorage, that it was not until 9 a.m. the signal could be made for the boats to advance towards the shore." Thus the men must have been nearly eight hours cramped up in the boats before they reached the beach, during which time, in these days, aided by steam, an army of 30,000 men, including artillery and cavalry, could be landed.

We read—"The force opposed to them consisted of 7000 * French troops, with fifteen pieces of artillery in position, commanding the whole space of disembarcation, and others with field-pieces and mortars in different excellent positions which the ground afforded.

"A fire of grape and musketry from behind sand-hills seemed to threaten the boats with destruction, while the castle of Aboukir maintained a constant and harassing fire on their right flank. Nevertheless the beach was arrived at, a footing obtained, and the enemy forced back from all his

* Royal Hospital, Chelsea,
March 27, 1862.

My dear Admiral,

As you seemed desirous to know the strength of the contending armies in Egypt (at Alexandria) in 1801, I wrote to a friend of mine at the Horse Guards, and he informed me that the French had 16,000 fighting men, and that John Bull had only 11,000. So that, in the hope that this bit of information may be useful to your lecturing friend, I send it to you. Believe me, very truly yours,

J. Morillyon Wilson,
A "Middy" of the Olden Time.

positions. The boats returned without delay for the second division, and before the evening of the 9th the whole army was landed."

What was done in 1801 can be done in 1862, with this difference, that with the aid of steam we ought to be able now to do in one hour what occupied many then.

"Buonaparte, availing himself of the perfect organization of a mighty empire, maintained an enormous army for some time on the barren ground above Boulogne." His preparations for invading this country were in themselve complete: *he wanted but one thing,—the command of the Channel.* Models of the boats and flats constructed under his direction may now be seen in the Museum of Artillery in Paris, and in the Model Room at Toulon. Who can say what might have been the result had he been able to land a large army on our shores; or, had he lived in this age of steam, to what his ambition might not have led him if the sea were for a moment left open?

The landing of the French in Algeria in 1838, and the capture of that stronghold, is another case in point.

The last example I shall quote, is that of the expedition to the Crimea in 1854, though I cannot pass unnoticed the very last expedition to China, under Vice-Admiral Sir James Hope and General Sir Hope Grant, it appears to have been an operation so perfectly and completely executed.

The British portion of the expedition to the Crimea consisted of 120 sail, including 10 ships of the line (two of them being screw steamers), 4 frigates (one of them being a screw steamer), 11 steamers of war (paddle and screw), 24 steam transports including three of Her Majesty's, 7 steam-tugs (a most valuable adjunct), and 64 sailing transports.

The British ships of war, with two or three exceptions, carried no troops; thus were they in the proud position of convoying squadron to the allied forces, all the French and Turkish ships of war being full of troops and *matériel* of war, because they had not such a transport fleet at their command.

The force (British) to be disembarked, consisted—

30,000 Infantry	54 guns	1624 horses for guns.		
2,192 Artillery		1530	„	Cavalry.
1,240 Cavalry		65	„	Staff.
		160	„	Regimental Staff.
33,452 men		3349 horses.		

Number of boats employed in landing men . . 326
Number of horse and gun flats 24

The allied flotilla when at sea numbered somewhere about 400 sail, and, as many of the ships were propelled by steam power, it was humorously said that Manchester had got adrift in the Black Sea, a remark that unwittingly reflected credit on the compact order of the transport fleet.

Arrangements were complete for landing at each trip 6,400 infantry, 12 guns, 216 artillery horses, and all the horses of the staff. It was decided by the late Lord Raglan not to land the engineers or cavalry until the whole of the infantry and artillery had been disembarked. At 7 a.m.

when the operation commenced, the water was smooth as glass; no enemy appeared to oppose the landing. As the ships were taking up position only one Russian officer with his mounted orderly appeared on the beach, and remained beside his horse for a considerable time, apparently occupied with his note-book, as though he were dotting down our proceedings, certainly neither contemplating a descent upon his shore, nor a departure from the rules of chivalry in the receipt of a warning shot. Suddenly our design seemed to burst upon his mind, and he beat a very hasty retreat, narrowly escaping capture, for the landing of the French troops further to the eastward had not been noticed.

By 6 p.m. 30,000 infantry and 24 guns, or four complete batteries, were landed; but sunset came upon us with a louring sky and a threatening swell breaking on the beach, a sure indication of approaching wind, rendering the disembarcation of artillery more and more tedious and difficult. At nightfall the weather was so bad, and sea heavy, that the operation had to be suspended. The troops had landed with three days' provisions in their havresacks, but without tents or camp equipage of any kind. Thus was that gallant army exposed for two days and nights on a hostile shore with no water except what fell from the heavens, not half its artillery, no shelter, and in the vicinity of a powerful enemy. There were ample grounds for anxiety on the part of the military chief; but the late Lord Raglan, who was by nature calm, knew that he was relying on the characteristic endurance and gallantry of British soldiers, and that at that moment he had under his command the flower of England's chivalry, therefore, when communication was again open between the fleet and the shore, not a murmur fell upon the ear. The cheerful and successful advance of the line has been elsewhere graphically described.

The foregoing examples strengthen my belief in the assertion with which I set out. In past times it has been seen that our own country has been twice successfully invaded and brought into subjection to a foreign yoke; and, if the sea be ever held in possession by a great military power hostile to England, there is no reason whatever why a powerful army should not again be landed in safety on her shores in spite of brick and mortar. I have heard a statesman put it thus:—"We cannot suppose for one moment that any foreign force could hold England; they might land and burn a coast town or two; but what would be the effect upon the world until England should be avenged for such an insult?"

Prevention is surely better than cure, and, whilst the highway to England is over the sea, there, and there only, is the place to defeat such an object. With the aid of steam an unopposed landing may be almost guaranteed; so many feints can be made, so many distractions practised, that a defending force on the shore would be harassed and worn out with fatigue, whilst the invader would land fresh. Even though an opposing force presented itself at the beach, it would be difficult for the men to maintain position in the face of a powerful covering artillery; but unless the sea were clear no wise man, however ambitious, would attempt to cross it for the purpose of invading a country. We well knew that Sebastopol was one of the strongest existing fortresses, likely to be heroically defended, as was proved by the expenditure of blood and

money in its reduction, but it certainly never entered my head that we could not convey and land an army safely on the shores of the Crimea; and the truth has been told, that the chief anxiety of the allied naval commanders-in-chief was an attack by the Russian fleet whilst at sea, not an opposed landing at the beach. Conceive a flotilla of crowded ships attacked in transit by an active naval force; destruction would be certain, and very feeble the resistance. In all the operations I have quoted, beyond the fact of their accomplishment, we have few details to aid the practical officer in preparing for such an undertaking. And, when I carry my mind back to that of 1854, I am more than ever sensible of the unpreparedness of the practical mind to grapple with them, and our lack of the proper appliances to ensure rapidity and precision. When we looked upon the vast amount of war *matériel* landing at Varna, with the necessity for keeping up supplies for an army, it was not to be wondered at that grave anxieties and doubts should exist in the minds of many men, after thirty years of peace, as to our powers afloat to convey such a force and land it successfully.

I now come to the second branch of my subject, viz., the points to be considered to ensure the success of such an operation as the landing of troops. The disembarcation of troops may be considered in three ways:—

1st. From transports in one of our own snug harbours, lying alongside a pier.

2nd. On a foreign shore, hostile to us, but offering no opposition, as in the Crimea.

3rd. On a shore in the face of an enemy.

In any of these cases celerity and precision should mark the operation, and these are only to be attained by careful arrangement. In the first, the disposition of the ship at the pier-side; the fitting and fixing of a commodious brow or broad passage-way of planking from the ship to the shore, where it should terminate in a clear space, so that the troops as they walk out can be formed and marched off without delay, care being taken that the sides of the brow be secured against accident by strong stancheons and side-ropes, and, if its angle of inclination be considerable, that cross-battens be nailed across it to prevent slipping; fatigue parties and guards being told off to land the baggage, &c. &c.

2nd and 3rd. If the landing is to be effected on a foreign shore, the strength of the force must be considered with a view to that likely to be opposed to it after they shall have landed; the beach or part of the coast must be well selected; the depth of water in close proximity to the beach, and the sort of beach, well ascertained; the ships to form the flotilla arranged and adapted to each arm, with a view to rapid disembarcation; the sailing and anchoring directions clear and explicit; the means for landing the force well and amply provided; the convoying or protecting fleet told off; the pivot and covering ships well instructed and in clever hands, for the execution of the operation with precision specially rests upon them; the direction of the wind, the barometrical indications, the rise and fall of tide; the instructions well understood by men as well as the officers; and finally, the heart to undertake it.

Thirdly. The duties of the seaman towards the soldier when embarked. I do not think I am claiming too much for the profession to which I

belong, when I say, that in every instance the operation of landing becomes the pivot upon which all subsequent moves depend. I may go further, and say that not one of the great military operations in which our arms have been borne with so much honour and glory by the sister service, could have been entered upon without the aid of the seaman. Our insular position renders this an axiom. The importance, therefore, of the subject to the naval officer cannot be over-rated; not only should he endeavour, as far as in him lies, to ensure a successful landing, but, by the care of the soldier when embarked, he should do his best to land him in an efficient condition for the ulterior work he has to go through. It behoves us, then, to begin at the beginning, and study well the requirements to ensure both.

The naval and military services being with us a matter of choice by the individuals composing them (and may we never depart from so wholesome a system), it is assumed that each person selects that for which he thinks himself by nature best qualified, carefully avoiding the characteristics of the other, or that to which he is in his nature opposed. It is therefore assumed that the soldier at sea or on shipboard is there solely in fulfilment of duty, and in opposition to his feelings and inclinations. It becomes, then, the special duty of the seaman to make such arrangements as will ensure to him the fullest amount of comfort, consistent with good discipline, when embarked, in order to his being landed in the same high physical condition as he was when he was received on board. The sanitary condition of the ship is, therefore, of the first consideration, and well-defined regulations under this head are in force under the orders of the Admiralty. The practical seaman understands the meaning of sweet bilges, clean holds, roomy well-ventilated 'tween-decks, good capacious hatchways, with independent trunkways to the lower from the upper decks, to ensure good ventilation. For these arrangements, the fitting of emigrant ships which have come under my observation is worthy of imitation for long voyages; though all ages of both sexes embark in them, the scale of mortality is small. The regulations of the Admiralty for the transport of troops appear to embrace every important point bearing on the welfare of the soldier. I need not do more than call attention to them.

I now come to the fourth branch of my subject, viz., the elements composing an army.

When we have considered and massed them, we shall have a better idea of the requirements necessary to a rapid disembarcation. To begin with the infantry soldier equipped for service in the field and ready to be landed. Is he not a living fortress of a most formidable character? Added to his rifle and sixty rounds of ammunition, he carries in his havresack provisions for three days; his supply of water; his blanket, great coat, pack of necessaries, being spare clothing, and camp-kettle, or cooking-pot. I have seen the French soldier carry, in addition to the foregoing, the *tentes d'abri*, considered by them valuable in hot climates on out-post duty; bundles of firewood slung to their waist-belts; and being more provident, as well as less scrupulous, beings than the British, two or three live tortoises, fowls, or ducks This man, so armed and equipped then, cannot be moved about in a boat after the manner of the unfettered seaman;

he must be allotted a sufficient standing-space in the boat that conveys him, and an easy passage from the boat to the shore, dry-shod if possible, and with dry ammunition. It would be as well to call in question the courage or endurance of the soldiers of Sparta as of Britain; but I have seen the very men who would have jumped into the sea up to their necks had an enemy appeared on the beach, show a strong disinclination to wet their feet when there was no opposing force, and, much to the vexation of their officers, accept the readily and cheerfully proffered shoulders of the seamen for a dry passage, it being no easy matter for the man equipped as I have described him to be, to get his boots off. Who will say that the disinclination was not prompted by common sense? who amongst us, after crossing a stream in an ordinary day's walk, has not experienced inconvenience, discomfort, and a galled heel from wet foot-gear, from which he was glad to seek relief in an immediate change on his arrival at home, where a good dinner and fireside awaited him? Common sense tells the soldier to avoid the evil if he can, as he has no such luxuries to look forward to: he may probably have a march before him; a battle to fight; a lie-out in the open for a couple of days or so on scanty rations in a pestiferous climate. Under such circumstances a sore foot ensues, which probably ulcerates if the man has been long on salt provisions, and he is compelled to fall out to seek the surgeon's attention: if this happen but to one per cent. of the force, see the embarrassment it causes the chief. I have made these remarks with a view to direct attention to the importance of details in their utmost minuteness when dealing with the arrangements for landing troops on a beach. In few words, it behoves the seaman not only to give his heart to the matter, but his best ability.

Thus much for the single soldier of infantry equipped for service; if we multiply the unit by 1000, we have the average strength of a regiment. Add to this number of men five horses for the regimental staff, two horses for the surgeon's implements, and at the least ten horses or mules for the reserve ammunition, and we have per regiment, to be conveyed and landed, 1000 *men and* 17 *horses*. Now to the Artillery.

A 12-pounder Armstrong gun and limber occupies, with the shafts out, 14 feet by 6 feet, weighs 37 cwt. 3 qrs., and is moved by six horses, each horse occupying 8 feet by 3. The ammunition wagon occcupies nearly the same space as the gun, weighs 43 cwt. 2 qrs., and is moved by 6 horses.

The horse artillery differs only from the field battery in having 8 horses for the guns.

The forge wagon weighs 32 cwt. 14 lbs.

A battery consists of—

6 guns, 6 officers, and 243 men for Horse Artillery.

6 guns, 6 officers, and 236 men for Field Artillery.

To each battery belong 11 ammunition wagons, 11 spare wagons and carts (such as forge and medicine,) and 224 horses.

Thus we have a tolerable idea of the means required for transport either by ship or boat.

A regiment of cavalry should, I believe, consist of from 400 to 500 men and horses, with a proportion of forge wagons and carts. For each division of an army we have to land 13 horses for the staff, and for the staff of the Commander-in-chief 20 horses. The military train bears the

following proportions to a *corps d'armée* of 14,000 men, viz., 574 men and 332 horses. Ambulance wagons, medicines and medical comforts, tents, stores, reserve amunition, the corps of engineers, engineering tools, wagons, carts, gabions, &c. &c. become a subsequent operation. Possibly the supply of provisions and water may have to be kept up by the fleet, as in the Crimea, for four days after the landing. Lastly, we have the siege train, which experience tells me should be placed in vessels not impracticable, with appliances for getting out the guns.

If we multiply the foregoing by any number, we get a general idea of the requirements for conveying and landing an army, which I shall now endeavour to set before you as the fifth branch of my subject, with a view to rapid disembarcation.

It must be apparent to the most unpractised mind that the ship suitable for the conveyance of artillery and cavalry across the Atlantic, in which horses would be low down, and guns and matériel carefully and securely stowed for the voyage, would not be alike applicable for an expeditious landing. It has therefore ever been found necessary to establish a rendezvous in some commodious, safe harbour, within easy distance of the coast on which the landing was to be effected, where re-arrangements were made and final instructions issued. Such a course is absolutely essential to success. I must explain to non-nautical men, that all hoisting from the holds or lower decks in a ship, particularly of horses and guns, involves a large expenditure of time and labour, neither of which can be afforded at such a moment.

To effect a rapid disembarcation, each ship should be selected to this end and prepared accordingly. Long low ships, or ships with commodious side-passages opening from the main deck, similar to those in some of our large troop and mail steamers, are the best. The shorter the descent the soldier of infantry has to make and the more commodious or easy the way, the quicker will he reach the boat. Strong accommodation ladders, or short flights of broad wooden steps, should be attached to each side—such were fitted at Varna to every transport; rope ladders with round steps of wood, termed by seamen "Jacob's ladders," should be suspended at intervals over the side, certainly not less than two on each side, one from the fore and one from the mizen channels, to facilitate the passage of stores and seamen, who would thus not interfere with the passage of the soldiers. The horses of the regimental staff should be with their regiment, ready on the deck nearest to the boat, on which an open passageway allowed of their being lowered into the boat, the instant the weight of each animal was taken in the slings. Slings should be ready in number equal to one-third the number of horses to go, and the purchase or pulley ready beforehand.

For the Artillery :—Long, low steamers, with clear upper decks, on which should stand the guns, waggons, and horses, for a complete battery, or portion of a battery, according to the size of the ship, it being clearly understood that the horses should be in the same ship as the guns and waggons, either in complete portions, or as a whole. Large open spaces should be prepared in the sides of the ships, so that the carriages, &c. could pass out clear so soon as the weight was taken; thus there would be no hoisting, but merely hauling taut and lowering; the purchases of course

being in their places beforehand; the same description of ladder is as essential in the artillery ship as for the infantry, but on one side only, for the men. The ship adapted to artillery would be alike suitable to cavalry. In any great operation, such as the landing of an army from a fleet of transports, it would facilitate matters much, if each vessel had marked on her side, in large clear characters, the number of the regiment, or battery of artillery, she had on board. Every transport is now numbered by order of the Admiralty, when employed in that service; and it would be quite easy to add what is required. This plan was adopted in the Crimea.

Having embarked our force in suitable ships, we have now to consider the most efficient means for disembarking it rapidly, and to this end we will speak:—

1st. Of the beach party of seamen and their duties.

2nd. Of the boat for landing infantry.

3rd. Of the boat for artillery or cavalry.

The officers and men forming the beach party should be distributed in boats (independent of those carrying troops) along the entire line, and in advance of the flotilla of disembarcation; the first and second officers in command should be in the centre, *i.e.*, in advance of the centre, and the third and fourth on the flanks; their boats should in fact be the leaders of the line. Certain men should be the bearers of flags on longish poles, the heels of which should be tipped or shod with iron for the purpose of planting on the beach as marks of approach for the whole line. Should any doubt exist as to the depth of water near the beach, these boats should pioneer the way by sounding. On the signal being given to land, they should dash on for the beach, preserving their distances right and left from the centre of landing; on the *instant* of arrival at the beach, the boats, being light, should be hauled up to make way for the general line coming in; the men charged with the flags should at once plant them as marks for the line to pull to, for nothing is more difficult than to preserve the relative distance abreast without such helps.

Military officers should be associated with the Naval officers in the beach duty, though of course exercising no authority over them, the service being purely one for the sailor to carry out.

The general duties of the beach party are to aid by every means in their power the operation of landing, by hauling the full boats in, and assisting to launch the empty or cleared boats. On those points at which the artillery is to be landed, the parties should be strong, as on them will depend entirely the quick performance of this most important part of the work.

Now to the troop-boat, so called, I consider the following to be the requirements: lightness of draught; buoyancy, with commodious internal space; easy of propulsion and management when loaded; portable by shipping; security against swamping. I know of no boat yet built that combines these; the last two, viz., portability and security, in a surf being considered essentials.

An ordinary boat appropriated to the conveyance of troops should be cleared of all encumbrances, such as masts, sails, oars, and breakers, the whole internal space being devoted to the soldiers. Her equipment should

consist of *four oars*, to be pulled in the foremost extremity or bow of the boat, slung so as to prevent their separation from the boat when thrown out on touching the beach, *one* steering oar, and no rudder. At the stern part of the boat a grapnel or small anchor and its cable; at the bow, a good long rope, called technically a painter; slung on the starboard outerside in beckets a good and substantial gangboard, and from the port or opposite outerside two strong poles tipped with metal at one end; two good boathooks with beckets worked on the hooks, similar to those in the Thames wherries, for securing a rope to for towing—in fact, like those in the model on the table. The crew to consist of six men, one to steer, one to attend to anchor and cable, four to pull the oars, attend the gangboards, &c., &c., it being, in my opinion, decidedly preferable to tow boats carrying troops, than to pull them with complete crews. Before arrangements can be made for landing it becomes necessary to test the capacity of each class of boat. I do not think any boat should have more than 40 soldiers in her at one time, if landing where opposition is certain; with that number she is not unmanageable from overweight. To use a homely phrase, "It is never wise to put too many eggs into one basket," and certainly not too many valuable soldiers into one boat, for obvious reasons.

I pass on to the boat or raft for landing artillery.

Considering the weight and space required for the gun, limber, horses, and gunners, we need a substantial safe craft of light draught, possessing the qualifications sought for in the troop-boat, and I am not aware of one suited to this work the model of which it would be wise to follow. The gun-flats extemporised by us in the Crimean expedition consisted of long, narrow, heavy Turkish stone boats, something resembling canal boats in shape (on a small scale) with greater height out of the water, each boat weighing from three to five tons, bow and stern being alike. These boats were secured in couplets, side by side, with strong transverse beams, three or four in number, as their length demanded. Over these a strong platform of planks was laid and stanchions were fixed at the angles and sides of the square thus formed. In some instances a boarding went along the sides to prevent the horses getting their legs over. When complete they must have cost about £150 each. A model of one is lying before you on the table.* Steamers' paddleboxes were coupled in a similar manner. The expense of these rough substitutes was great, the time occupied in fitting them considerable, and when completed they were clumsy, unwieldy craft, very difficult to stow on shipboard. In fact, they were necessarily fitted to be carried over in parts, to be put together at the scene of operations. Each ship carried a couple or more of such boats suspended in lashings from her side, and all the gear appertaining to them on deck. After a few rehearsals, the process of coupling them together and preparing them for work was accomplished in about half-an-hour. In the preparation of such boats or rafts it is necessary to use as few nails as possible, or that the nailheads be so countersunk as to prevent injury to the horses. I witnessed many wounds to the animals from want of attention to this item.

* Models of these flat-boats, and of the pontoon-raft proposed by Captain Mends, and presented by him, are in the Museum of the Institution.—Ed.

These boats, nevertheless, did important work, and had some points of practical utility. I am of opinion that something on a similar principle would prove serviceable: the boats being in pairs with whale-boat ends were really good sea-boats and tolerably manageable; the passage of the sea between them made it easy to keep them end on; they towed and steered easily with steering oars; each one of the larger class carried two guns with the limbers, twelve horses, and the gunners, with ease.

The French have been in the habit of using a large flat-bottomed, tray-shaped boat, called a *chalande*, of which each ship of the line usually carries two during such operations, one on each outer side, stowed flat to the side and bottom outwards, resting on strong solid chocks bolted on to the wales, as our ships of the line in the olden time carried large troop-boats. A strong parbuckle sling passes round them, with which they are hoisted into place by the yard and stay purchases, and secured by lashings; they are by these means lowered readily into the water. When stowed, the lower edges or sides of the boat are so near the water that they could not be carried in such a position in safety during stormy weather. The advantages of the *chalande* are, that they are easy of construction by unskilled workmen of ordinary wood; that they are quickly ready for work, and in fine smooth weather do a great deal for which an ordinary boat is not adapted. A model of one is upon the table. Their cost is somewhere about 100*l.* each. The disadvantages are many and serious; they are difficult to carry on shipboard in safety; they are very heavy; very slow, being difficult to tow; very difficult to steer, and very bad sea-boats. Several swamped at the landing in the Crimea, the guns going to the bottom, and the horses where instinct guided them. One, when on its passage between the ship and the shore at Varna, full of troops, was accidentally struck by a small tug steamer, which caused her instantly to founder, by which many lives were lost, the men having their packs on and arms in their hands. I hear the French have adopted a better description of boat in iron for future operations. As the Crimean war progresssd, horse-boats were built at Malta and sent to the Crimea, but they had the disadvantage of being cumbersome and weak. Similar boats have been used in the late operations in China and complained of as weak, being necessarily without thwarts and having a falling stern. Probably, some who are present this evening may know the *balso*, a small double boat of inflated hides, used by the natives on the west coast of South America to pass the surfs prevalent on their coasts, and that on these boats are brought off bread, fruit, vegetables, &c., quite dry. On the east coast of South America, we have the catamaran for the passage of equally heavy surfs, a description of craft possessing considerable stability, capable of carrying goods from one port to another under sail, easy of propulsion by paddles, and easily guided.

At Madras a similar bark passes the surf with ease, and at Galle, in Ceylon, we have the double canoe. It has struck me that the principles upon which these boats or craft are constructed—I mean the double boat of the Crimea, the balso, and the catamaran—and do well, may be advantageously applied to the construction of a raft for troops, guns, and horses. I think iron may be made available. I propose long light iron cylinders, laid side by side, connected by beams of wood and planked over to form a raft, like the model on the table, which has been made under

my directions. I think such a raft will be found to combine more nearly than any other description of craft all the requirements sought for, viz., light draught, buoyancy, commodious space, ease of propulsion and steerage, portability and safety, at no great cost—if made in our own yards about 150*l*. Every transport has in these days one or two good shipwrights, and, if she be a steamer, she has also some clever engineers; but I propose that one shipwright, assisted by seamen, shall be able to put one together. By making the cylinder boat of iron a little thicker at the bottom than at the top, we ensure to it sufficient stability or steadiness when placed in the water to receive the connecting beams and platform. The lining over the bottom is of elm, for the purpose of protecting the iron against rock or rough stones on a beach. Each cylinder of 35 feet will weigh about three-quarters of a ton, say a ton, and bear up 10 tons weight, and I see no reason why the long steam transports of the present day should not carry five of them *for war service*, three being for a gun flat and two for a troop flat. They might be secured in crutches along the outer side of the ship and lashed or stowed on skids over her quarterdeck, where some of the ships of the line carried extra boats to the Crimea. The London, I think, carried no less than eleven or thirteen good boats in that position. The wood-work should be clearly numbered so as to make it next to impossible for a man of ordinary intelligence to go wrong. I think it may be made of sufficient strength of material without adding excessively to the weight to work a field-gun upon. In case of an iron ship getting on shore, such a raft might be put together on two strong spars, laid across the gunwales between the fore and main masts, and easily launched from that position to the sea with the aid of two up-and-down purchases.

At any rate, whatever may be its merits or demerits, I lay it before the Institution with a view to raising discussion on what is really important matter. We ought to be prepared with some well-approved model against the day of war, when any number could be run up rapidly at much smaller cost than if we had to scramble through difficulties as we did in the Black Sea, at a heavy expenditure and delay, which might have proved more disastrous in their consequences than they did.

When active war operations are going on, and the transport service is in full play, nothing requires more consideration than the stowage of war-like stores, provisions, clothing, and medical comforts in the ships selected for the purpose. Those in this country entrusted with this duty are apt to think, that, if they have got into the ship the number of tons of stores they have received orders to ship, they have done their duty. The use of cranes, and every possible mechanical appliance being brought to bear on the process of loading, the work is quickly performed, and the public is satisfied, by the announcement of the ship's departure in reasonable time, that all is well.

The difficulties attending the discharge at the seat of war are lost sight of, as well as the possible want of any one portion of a cargo before another. Many of the reflections on the maladministration of matters in Balaclava harbour might, with justice, have been cast upon the want of attention to this matter at home. Balaclava, a mere indent of the sea, tortuous and deep, had to contain some of the largest and finest ships the world had produced. Its inhabitants having consisted of a few petty

traders, fishermen, and government *employés*, they had not prepared fine wharves, cranes, neither a ring nor a bollard to which a rope could be secured, and yet I do not think any harbour of its size ever had had before or since so many fine vessels at one time within it. Being the first naval officer who entered, as it fell into our hands, I saw it in all its purity, a clean village resting upon a harbour, deep, clear, and unruffled, except by the ducks and geese disporting themselves on its surface, little suspecting that their career would so soon terminate in the pot of the soldier. Ships were, so to speak, tumbled in, containing provisions, tents, camp equipage, &c.; on the second morning our 91-gun ship was among the number safely moored within it, and I shall not forget the cheer with which the troops received her. The siege train was soon required; the ships having it on board were ordered in; but if two more inaccessible vessels had been looked for in the whole mercantile marine, or more inconveniently stowed, with fewer appliances for getting out such weights, I do not think they could have been found. Delay, of course, occurred in clearing them, whilst they occupied spaces much wanted for ships with provisions, &c., demands from the front pressing for everything at once.

I come now to the last branch of my subject, viz., the organisation of a force with a view to rapid disembarcation. Bacon says: "For when things are once come to the execution there is no secrecy comparable to celerity." We will suppose an army embarked in ships selected, adapted, and prepared, as I have endeavoured to describe they should be, the boats and rafts wherewith to land a given number expeditiously and safely (I see nothing to prevent 10,000 infantry and 24 guns being carried at one trip; allowing each to occupy two hours, which is a long time, in six hours we have 30,000 infantry and 72 guns on shore); steamtugs (either armed or not) attached to artillery rafts; the covering gunboats told off; the pivot ships to insure a close and precise anchorage; the convoying fleet in readiness, and the highway clear; the order of sailing and anchoring well defined for night as well as day; each division carrying distinguishing flags *by* day and special lights at night, and the instructions for the operation clearly understood by all ranks. We wait the signal of the Commander-in-Chief to weigh, who doubtless would consult his barometer and tide-table before giving his order. It would insure rapidity if the ships carrying troops had the means within them for disembarking, without being dependent on extraneous aid, which from uncontrollable causes may be tardy in arrival.

Plates I. and II. represent the order of anchoring and sailing of the transports and array of boats proceeding to the shore of the Crimea with the First Division, followed by the artillery.

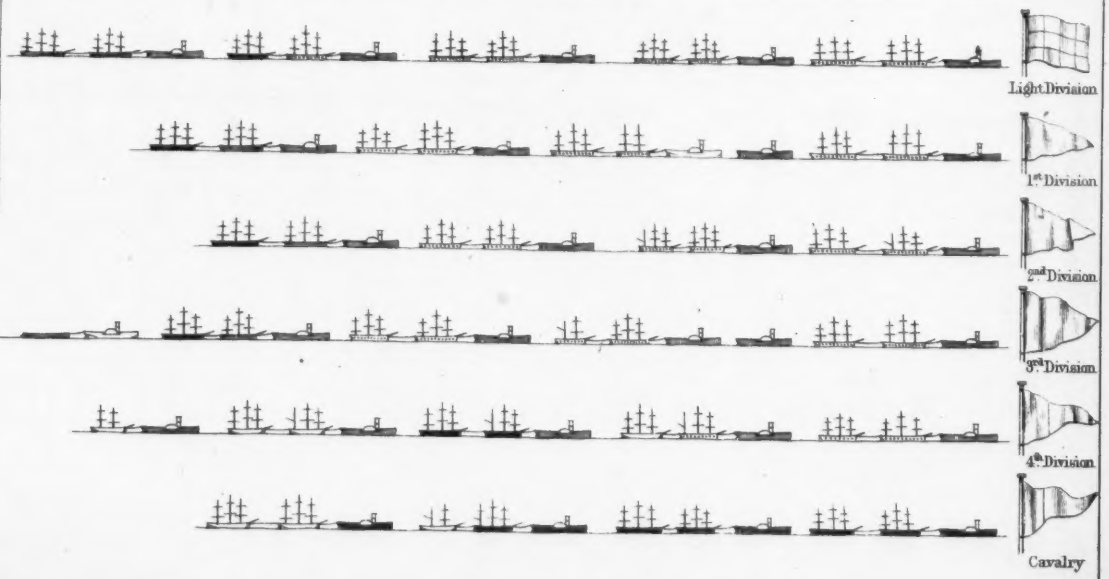
It remains for me to return you my best thanks for the patient hearing you have given to a somewhat rambling paper; I shall be repaid if it induce professional men to turn their attention to the very important subject of disembarking troops; for, though England is not an aggressive nation, circumstances may compel her again to land troops on a foreign land, unless indeed (*unhappily*) the brick and mortar defences rising around us should lull the nation into a false security, and induce England to yield up her natural strength for attack or defence upon the sea.

ORDER OF ANCHORING AND SAILING.

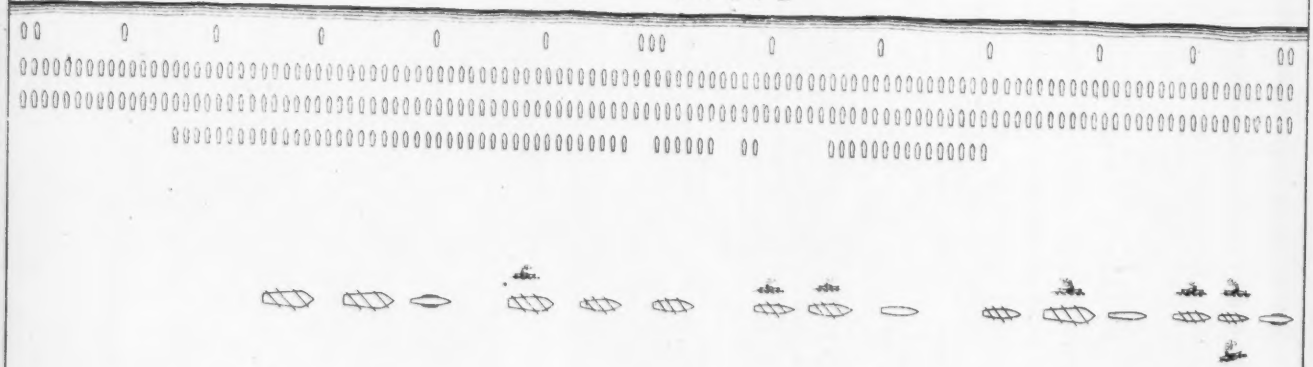
Reference.

- Steam Tug
- Steamer
- Infantry
- Artillery
- Cavalry
- Reserve Ammn.

The Beach



ORDER OF LANDING.



J.R.Jobbins

Lord DE ROS: Could not the pontoons that are used for military bridges be made available? They are of the same shape.

Captain MENDS: I think they might; but I rather think the pontoons are made of equal thickness of iron, and you want a certain stability. If you have the least sea on in putting them together, they would wobble about immensely. That is the difficulty. I think by giving them a thicker iron at the bottom than at the top you give them a certain stability; and then the seamen would have less difficulty in putting them together. They are easily launched, and I think one ought to be put together in twenty minutes if the men are well practised.

Lord DE ROS: I apprehend that with the same materials for landing infantry you could make two pontoons.

Captain MENDS: Yes; I think so: they might make two for infantry, but one for guns and horses.

The CHAIRMAN: I would only observe here that we are greatly indebted to an officer whose official duties occupy a great deal of his time, for preparing so elaborate and so complete a statement as he has given us this evening. The question is one of the highest importance; and the more it is considered the more apparent are the difficulties we have to contend with in carrying out an operation of this kind. Completely as Captain Mends has gone into the question of landing, there is yet a further point, respecting which I hope some gentleman present will give us information, and that is, as to the erection of piers for embarcation, in an artificial manner. Where there are a great many troops engaged, the erection of piers is of the greatest importance. I should also like to know—I do not know whether recourse was had to it in the Crimea—whether oil or something of that kind, could be used to prevent the effect of swell upon the beach.

Lord DE ROS: I dare say Captain Mends will recollect, at Varna, the French piers were made of casks, which answered admirably well for the embarkation; and that our own engineers on the opposite side of the bay used faggot-piers, made very ingeniously. They answered exceedingly well. They were merely made of faggots pegged in; they became very solid when the earth was put on, and lasted a long time.

Commander SCOTT, R.N.: Where would the covering vessels be placed with respect to the fleet of transports—the vessels to protect the landing if the landing were opposed?

Captain MENDS: The covering vessels would anchor in a position with respect to the beach where the draught of water would enable them to cover the whole line, on points settled by the Naval Commander-in-Chief at the time. The covering vessels are not shown on the diagram.

Commander SCOTT: I asked the question because it is an important part of the arrangements—the position of the covering vessels—if a landing were opposed.

Captain MENDS: There is no doubt of it.

Commander SCOTT: You mentioned, particularly, the decks of your transports. Do you intend the transports to carry guns or not?

Captain MENDS: I think not.—The Chairman made some reference to artificial piers. It was seriously contemplated—in fact, had the surf held on another four hours, we should have sunk a couple of transports to protect the beach. They would have formed a very good breakwater in a very short time. No one would have hesitated to do such a thing. In fact, as the men had been landed with only three days' provisions, I should have done it on the setting in of bad weather, had I been in command.

Lt.-Colonel COLLINSON, R.E.: I should like to ask whether Captain Mends has ever considered the arriving at any organization of a system of disembarking troops; so that, not each vessel, but each division of vessels, should be able to proceed by signals without waiting for further arrangements? I think you propose that each transport should carry the means of disembarking troops. I should like to ask whether you have determined upon any particular size or description of raft, to carry a certain number of troops, so that vessels could be supplied with the required number? So that there would be, as it were, a certain unit of disembarcation—rafts of a particular size to land a certain number of troops, vessels of a fixed tounage capable of carrying a definite number of troops, supplied with the requisite number of rafts for that purpose. I also wish to ask with respect to that model of a raft, what is the scale of it, and the number of men it would carry? I daresay you are quite aware of the description of pontoons used in the British service. I should think they are rather larger than those which you have shown, though somewhat of the same appearance and shape.

Lord DE ROS: The pontoons are thirty feet long, are they not?

Lt.-Colonel COLLINSON: No; they are twenty-four feet; and they are placed, gene-

rally, at an interval of twelve feet, and they are so organised and manœuvred that they are capable of being worked in pairs to form a raft about twelve feet by ten, possessing a buoyancy sufficient to carry thirty men. That raft can be worked in the tidal way of a river, but I do not know that it has ever been tried in a sea-way at all.

Lord De Ros: You are alluding to General Pasley's raft, a boat-shaped raft.

Lt.-Colonel Collinson: No; not General Pasley's, but General Blanchard's cylinder raft; that is the one which is now used in the British service. General Pasley's is not the same shape, but made of the same material, which is metal. There has also been another description of pontoon lately proposed which has been brought before this Institution, the invention of Captain Fowke, of the Engineers.* It is a portable raft made of canvas. It may be briefly described as being transverse frames of wood, connected together by canvas, so that they collapse longitudinally into a space of three or four feet cube, and will expand into a long boat-shaped cylinder; not a closed cylinder at all, but a boat-shaped cylinder with an opening—a sort of long hatchway in the top of about twenty-two feet long, and four or five feet beam. Two of these together would give a very considerable buoyancy. There is, of course, a difficulty in using canvas vessels in water, and that is to keep them rigid underneath at the bottom, which causes a very great obstruction to the movement in the water, requiring a very great power of movement to propel them. I suspect that in using any description of pontoon raft, whether of canvas or of metal, there will always be found very great difficulty in moving them in the water. They would require considerable power. Otherwise, if you have that power, which perhaps you may obtain by steam, then they offer very great advantages from their stability and buoyancy, and their flat deck. Therefore, what I want to ask, with respect to that particular raft, is, the power or buoyancy of it, the space in it, whether it is available for infantry, cavalry, and artillery; and whether you have in your mind a sort of unit of a raft that would be available for all services, and as to how many of them a vessel, of any tonnage you like to mention, would be required to carry: and further, if you could state, with any degree of determination, the time that would be required to land any definite number of men; because of course that must depend upon the unit that you adopt.

Lord De Ros: And upon the weather.

Lt.-Colonel Collinson: We must assume a certain definite weather. If we go into that question we shall have an endless discussion.

Lord De Ros: The canvas would hardly do on a beach.

Lt.-Colonel Collinson: I will assume favourable weather, a favourable beach, a favourable opportunity, and you have got to land a division of the army, or any section of the army that you choose to name. How many boats or rafts would be required to land them in a certain time? Is it possible to state that, so that, by simply multiplying the number of rafts and vessels, you would be able to land any force you please in a given time?

Captain Mends: In drawing up this paper I had in my mind specially, rapid disembarcation. I cannot say I have gone closely into the calculation so as to answer correctly the questions you have put to me. Nor would it be possible to do so, unless the whole of the transports employed were alike in the first place. It must be a thing to be organised at the moment. Some practical person conversant with the whole affair must organise it and arrange it at the moment. I certainly feel that, in order to disembark rapidly, the transports should have within them the means of landing the men; that they should convey their boats, and rafts for artillery, if requisite; that the steam-tugs should be near them, and that they should do the whole work, having men in them to hoist the guns, horses, and gear out, independently of the troops, and independently of the ships of war. I feel satisfied it would be more quickly done. I see no reason whatever, assuming a fleet of transports near the shore with proper organisation, why ten thousand men, with twenty-four guns with their limbers and horses, should not be landed in two hours. Therefore, in six hours, I would have thirty thousand men and seventy-two pieces of artillery on shore. I think it ought to be done, and I think it can be done. I have not seen Captain Fowke's pontoons; I have seen the cylinders of light iron used by the engineers for pontoons, but I have never seen anything approaching to what I conceive would be useful in even moderate weather at sea. The length of each of these cylinders on the table would be thirty-five feet in the extreme, and it would have a displacement of ten tons, sixteen hundred-weight; so that, with four, I could get to bear about forty-three tons. The platform formed within the square is thirty feet square, so that I could certainly carry

* For a description of this raft, see Journal of the Institution, vol. iv. p. 237.—Ed.

with perfect ease two guns, limbers and horses for them, and I should think about seventy or eighty men would stand upon that platform. I have not tried it, but I guarded myself in my paper in that particular, that it is always necessary, previous to embarking, to rehearse and test what each boat will carry before you draw up the arrangement. In the landing at the Crimea we were obliged to go through the experiment with every class of boat, and we knew exactly what each could do. I arranged for landing six thousand four hundred men and twelve guns in each trip. Had all things gone on in accordance with the arrangements, I believe I should have landed them in six hours; I see nothing to have prevented it. Of course such an operation depends upon the precision with which the fleet of transports is brought to the anchorage before the beach,—the sea, and so on.

Lord De Ros: Captain Fowke's pontoon is capable for river, but it would not do for beach work.

Captain Mends: It has been suggested to me since this model was made, that it would not be perforated by musketry, and, even if struck by a shot or two, the raft would not give way at all. I do not see how Captain Fowke's pontoon could be used upon a beach.

Lord De Ros: The canvas would tear to pieces.

Captain Mends: It was suggested to me to run a fore-and-aft compartment, a longitudinal compartment, in each cylinder; it would strengthen them very much without adding much to their weight. They would not then weigh a ton each, and would certainly stand a shot or two.

Lt.-Colonel Collinson: How would you carry them on board ship?

Captain Mends: I stated in my paper that they could be slung outside, lashed in crutches, where I think they could be carried in almost any weather, or on skids over the quarter-deck.

Lord De Ros: Do you hold much to the thickness of the bottom? because they are very easily steadied, and immediately they are placed in the water the oars can be used.

Captain Mends: When you first put them over into the water, with the least ripple at all, they would roll about, unless steadied at the bottom. It would be a great thing that they should be in some measure floated upright before being connected, in order to facilitate the operation.

Lord De Ros: They would not turn in the slings till you got the sleepers across on them.

Captain Mends: But they must be thrown over altogether. They must be run into the water, and the seamen should be able to lash the spars to them across the top, and they must be steadied while the seamen connect them, with the three spars underneath. I think that would be quickly done with a common lashing; the first lashing or two will steady them. With a little rehearsal and a little exercise I would undertake to rig a raft of this sort, with some good seamen and a shipwright, in twenty minutes.

Lt.-Colonel Collinson: Supposing you had to carry a battalion of eight hundred men in one vessel, I think that raft, by your description, ought to carry one hundred and twenty men.

Captain Mends: I daresay it would, but I should be very sorry to put one hundred and twenty men upon it to land on a beach if there is the least chance of opposition. I must however say this was entirely departed from in the Crimea; we had little light draught steamers purchased from an Austrian company, and each of them carried a regiment. I think the Guards were then very near a thousand strong, they had not then been decimated; each one carried a regiment of Guards, and ran in on to the beach, and the disembarcation was done most rapidly.

Lt.-Colonel Collinson: Supposing the raft carried one hundred men, then, a transport that would carry a battalion would require eight such rafts; that is, thirty-two of these cylinders or pontoons.

Lord De Ros: That is to suppose you would land all at one trip, which you would not do.

Lt.-Colonel Collinson: I suppose, when you say you would land ten thousand men at one trip, you mean that you would take that number of men out of a certain number of vessels?

Captain Mends: No, because you could not get the men rapidly enough into the boat; you could take a certain number of men, but you would not be able to get a sufficient number of boats alongside at once for so large a number from one ship.

The Chairman: I am sure you will join with me in returning our thanks to Captain Mends for his kindness in reading this able paper.

Evening Meeting.

Monday, May 5th, 1862.

CAPTAIN E. G. FISHBOURNE, R.N., C.B., in the Chair.

Names of Members who joined the Institution between the 7th April and 5th May.

Life.

Evans, T. W., Dept. Lieut. Derbyshire, 9*l*.
Vernon, Lord, Major, Derbyshire Rifle Vols., 9*l*.

Annual.

Adams, C., Lt. Col. 49th Regiment, 1*l*.
Arthur, W., Comr. R. N. 1*l*.
Allardice, G. J. C., Ens. 50th Regt. 1*l*.
Baynes, G. E., Major, 1st Bat. 8th King's, 1*l*.
Benyon, W. H., Ens. 2nd Bat. 23rd R. W. Fus.
Cockran, T., Capt. R. N. 1*l*.
Crofton, H. A., Captain, Adj. Monaghan Mil. 1*l*.
Currie, A. D., Ens. 41st Regt. 1*l*.
Doveton, J. E. C., Ens. 50th Regt. 1*l*.
Dunn, J., Ens. 41st Regt. 1*l*.
Gage, Hon. E. T., Lt. Col. R. A. 1*l*.
Garratt, F., Capt. late 3rd Dn. Gds. 1*l*.
Hardy, F., Capt. 84th Regt. 1*l*.
Johnson, E., Lieut. Rifle Brigade, 1*l*.
Maunsell, F. R., Major Roy. Bengal Eng. 1*l*.
Moore, R. C., Col. Royal Madras Art. 1*l*.
Nepean, E. C., Esq., Clerk at War Office.
Pinder, G., Col. Retd. Full Pay, 1*l*.
Scrymgour, W., Capt. R. N. 1*l*.
Skipton, S. S., Asst. Sur. 78th Highrs. 1*l*.
Smith, F. H., Com. R. N. 1*l*.
Smith, J. W., Ens. 2nd Bat. 1st Royals, 1*l*.
Symonds, C. E. H., Lieut. R. A.
Tupper, D. W., Capt. 50th Regt. 1*l*.
Turner, G. Esq., Master Shipwright, 1*l*.
Williamson, R. F., Ens. 2nd Bat. 23d R. W. Fus.

THE SHAPE OF SWORD BLADES.

By Mr. JOHN LATHAM, firm of Messrs. Wilkinson and Son.

In the course of an experience of nearly twenty years in the manufacture of swords, I have frequently noticed in examining any pattern, or model, which I have not met with before, how instinctively the shape seems to suggest the best method of using the weapon; and I have almost invariably found upon inquiry that the method of swordsmanship adopted was the same that I had supposed.

A moment's reflection is sufficient to show that there is nothing extraordinary in this. A swordsman selects or constructs his weapon on exactly the same principles as a carpenter chooses his tools, and if you show a workman a chisel from any part of the world, though he may

never have seen the pattern before, he will tell you at once the use to which it should be applied. He will know, for instance, that it is not intended to drive nails, or bore holes; that its office is to cut wood or some soft substance, and not iron or steel. He recognises these points at once from the shape, the angle of edge, its temper, weight, &c.; and in the same way, by examining a sword of whatever country, we can form a pretty correct estimate of the method of swordsmanship adopted there. Having noted a great number of peculiarities of this kind, some of which seem to me very curious, I have arranged them in a short paper, in the hope that they may prove as interesting to you as they have been to myself.

We may very fairly surmise that the origin of the sword as a weapon of attack was the idea of some ingenious savage, who fashioned his wooden club to a rude approach to a cutting edge, probably from noticing the effect of a knot, or some accidental projection upon it. The wooden swords with which the Mexicans were armed when first discovered by the Spaniards, and those of the South Sea Islanders, of which there are many specimens in the Museum of this Institution, are instances of this, being hardly more than sharpened clubs.

In nations more civilised, swords were made in the hardest metal procurable. Copper swords have been found in Ireland; iron among the Britons and Gauls; bronze was used by the Romans, and probably by the Egyptians; and steel of varying degrees of hardness is now the only metal employed.

Upon the questions of the material, temper, or manufacture of swords, I do not propose to touch, but only upon their shape, which is, as I have said, determined by the way in which they are to be used. There are three ways in which a sword may be used, viz. in cutting, thrusting, and guarding. The first of these, cutting, I have assumed to be the earliest use which would suggest itself; but the man who first employed the sword for thrusting made a discovery which more than doubled the effective force of the weapon; and, still later, the one who first used it to defend himself from the attack of his adversary, as well as to return his blows, completed the idea of the sword, as it is now understood in Europe. It is in this triple character, as a weapon for cutting, thrusting, and guarding, that I propose to consider it. If these three qualifications could be combined in their fullest extent, there would be no difficulty in deciding upon the best form for a sword; but, unfortunately, each interferes with the other to a great degree, and therefore it will be best to consider them separately, which will also enable us to understand more clearly the various modifications of shape in use in different parts of the world.

The most simple and effective form of a cutting instrument, to be used by the hand, is the American axe. This is the same form as the early headsman's, or executioner's, axe, but is generally known in this country as the American, from its being the form used by the settlers for clearing the forests in the backwoods of America. It consists merely, as you see, of a heavy wedge of steel, fixed on a stout wooden handle of convenient length.

The first thing we notice in this weapon is, that there is no uncertainty where you shall strike with it. It has a light handle and a very heavy

head, and, all the force being concentrated in the head, you strike instinctively with that part of it; but, if you take up a sword, you have the whole length of the blade to choose where you shall cut with it. Suppose you make a cut at a branch of a tree with the point of the sword, the probability is that your cut will produce very little effect, and you will feel a considerable jar upon the wrist and elbow. The same result will follow if you cut close to the hilt of the sword. In either case you waste a great deal of force, as is evident from the vibration you perceive in the blade, which represents so much force lost in the cut. If you go on cutting inch by inch along the whole length of the blade, you will at last come to a point where there is no vibration (Plate I. fig. 1, C. P.). This point is called the "centre of percussion," and that is the point where the whole force of your blow will be effective, and where the greatest result will be produced on the body struck. This model on the table illustrates the position and effect of the centre of percussion. It consists of a straight wooden blade jointed in the middle so as to bend freely in either direction, and the centre of percussion is marked, as you will see, at about 10 inches from the point. If I set the blade straight and cut with it, so long as the blow strikes exactly upon the centre of percussion no effect is produced upon the blade; but, if I shift the cut either an inch above or below that point, the vibration produced causes the blade to bend at the jointed part; if I strike above the centre of percussion, the blade bends backward; and, if I strike below it, the vibration is in the opposite direction, and is sufficient to bend it forwards considerably. As I have explained, the centre of percussion can be experimentally ascertained by cutting inch by inch along the blade, and comparing the effect; but it is obviously of importance to have some means of ascertaining this point mathematically without the tedious process of experiment with every sword. This can be done by a formula, first proposed by Mr. Henry Wilkinson, and which is based upon the consideration of the properties of the pendulum. I have here a pendulum vibrating seconds in the latitude of London. Its exact length is 39·2 inches, and it consists of a very light wooden rod, terminated by a heavy leaden ball. In one respect it resembles the axe, as nearly the whole weight is concentrated in this one point. When I cause it to swing upon a fixed centre, I find it makes sixty vibrations in one minute; and I know that the centres of oscillation, of percussion, and of gravity are all concentrated within this leaden ball. If this were what is termed a mathematical pendulum, in which the connecting rod is supposed to have no weight at all, these three points would lie precisely in the centre of the ball, and from this point to the point of suspension is exactly 39·2 inches. Now, I hang up this regulation Infantry sword, fastening it as nearly as possible at the same point on which it would turn in making a cut, and I set it swinging upon this point, converting, in fact, the sword into a pendulum. You observe that the vibrations are very much quicker; if you count them, you will find that while the pendulum is making sixty vibrations the sword will have made eighty. Having obtained this point of comparison, our object is next to determine the length of a pendulum which will make the same number of vibrations which the sword has made, viz. eighty in a minute. By a very simple formula, I can calculate that the length of such a pendulum would be 22 inches. I measure this distance, therefore, from the point at which the sword was

Fig. 1.

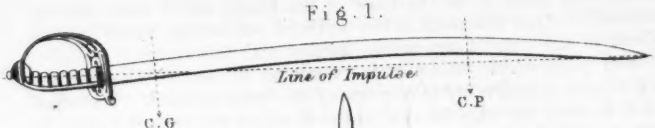


Fig. 2.

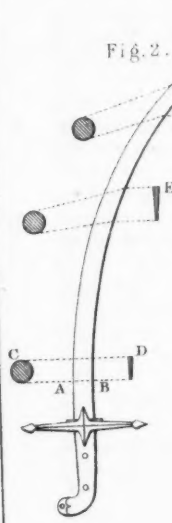


Fig. 3.

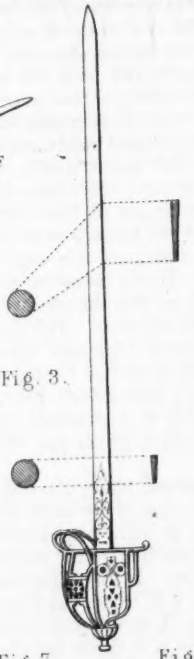


Fig. 4.

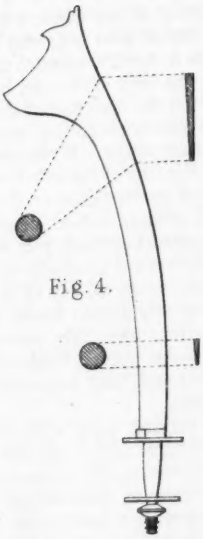


Fig. 5.

Fig. 6.

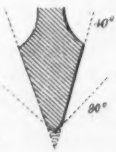
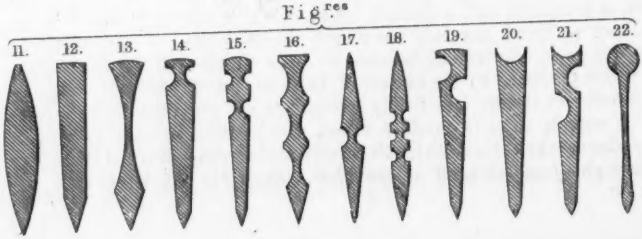


Fig. 7.

Fig. 8.

Fig. 9.

Figures



J.R.Jobbins.

suspended and mark it on the back of the blade, and I shall find on cutting with it that this mark is the centre of percussion, where there is no vibration, and where I can cut the hardest with this sword.

Another point which we notice in examining the axe is this, that the cutting edge is considerably in advance of the wrist or hand. The effect of this is to carry the edge forward in the direction you wish it to take in making a cut with it. If the cutting edge were placed at the back, the tendency of the whole weapon would be to fall backwards, or away from the line of your cut; and in making a blow you would have to exert and waste a certain amount of force to overcome this tendency. Instead of this, the edge of the axe, being placed in advance of the wrist, moves naturally in the direction of the blow struck with it.

In nearly all cutting swords some contrivance is made use of to produce a similar effect. If we examine any of these curved swords we shall see that the line of the hilt is thrown forward so as to form an angle with the line of prolongation of the blade, and this angle is more or less as the blade is more or less curved. If you endeavour to balance the sword upon the pommel or rivet, you will see that the effect of this is to cause the edge to fall forward precisely as the axe does. This gives the feeling which we express when we say of a sword "the edge leads forward well;" and I have nearly always found this point has been studied in the swords used by nations who make cutting a part of their system of swordsmanship.

But the curved blade which is so universal among these swords has another and very important effect, which you will understand from this diagram.

In making a cut with a curved blade, the edge meets the object at a considerable angle, and the portion of the blade which penetrates is therefore a wedge, not accurately at right angles with the sword, but of an angle more or less oblique according to the curvature, and consequently cutting with a more acute edge. In this diagram (fig. 2), if the sword-blade move in a straight line, A B, to cut any object, C, it will merely cut in the same way that a wedge, D, of the same breadth as the blade would do. But the effect of the curve is to throw the edge more forward, so that it cuts as a wedge, E, which you will see is longer and consequently more acute, the extreme thickness (that of the back) being fixed. In the same way in cutting nearer the point the increased curve gives, as you see, the effect of a still more acute wedge, F. In order to explain this more clearly I have made a small model similar to the diagram. If you compare these three pieces, which are parts cut out of the same blade, differing only in the angle at which they are supposed to meet with any obstacle, you will see the enormous cutting power which is produced by this oblique motion of the sword. We may say that the effect of the curve in this Indian tulwar, as compared with a straight blade, is, that it cuts as though it were four times as broad and only one-fourth the thickness. I have selected the tulwar as an illustration, because we have all heard of the extraordinary effects produced by the natives of India in cutting with this weapon. Men inferior in stature and bodily strength to our own countrymen can use this weapon so as to produce effects which strike us with astonishment:—heads taken off—both hands severed at the wrist—arm and shoulder cut through—legs taken off at one blow. Such are the sword-cuts of

which our soldiers had too fearful experience during the Sikh war and later campaigns in India.

To understand more clearly how such effects can be produced, we must distinguish the different methods of cutting. In the first place I may take up a sword, and, keeping the elbow and wrist stiff, may make a sweeping cut with it, throwing the whole force of the body into the blow. To use as simple terms as possible, I will distinguish this as the "slicing" cut. In the next place I may take the sword, and, as an Englishman generally does, make a downright blow from the shoulder and fore-arm. This appears to be the instinctive method of cutting with a sword, as we find that most people who take up a sword for the first time use it in this way. We may distinguish this as the "chopping" cut. Or we may use a light sword in the way the German students use the "schläger" in their duels, keeping the elbow and arm stiff and making a quick cut from the wrist. This we will call the "whip" cut.

Now very different muscles are brought into play in these three methods of cutting. With the Indian tulwar, the first, or slicing cut, is used, and in this the cut is really given from the strong muscles of the back and shoulder, and, as these have nearly ten times the extent of the muscles of the arm, and the whole weight of the body is also thrown into the cut, you can easily understand the force with which such a blow is given. The second kind of cut, which is the one usually employed in Europe, is made with a movement of the shoulder and forearm. As a rule it cannot be compared in its effect, especially upon soft bodies, with the slicing cut given by the natives of India, and the large hilt, necessary to afford sufficient play to the wrist, lessens the cutting force still further. The small hilt of the tulwar, by confining the hand and preventing any play of the wrist, increases the force of the slicing or body cut. It is customary to say that these swords have such small hilts because the natives have small hands. My own hand is not a very small one, but I find no difficulty in using any of these Indian swords in the way in which they are intended to be used. The hand being confined in the hilt gives a stiffness to the wrist, so that the whole force is thrown into the blow. The wrist-cut can also be used with great effect, from the high velocity which can be given to a light sword by using it in this way. The German students who use this cut in their duels with the schläger are frequently fearfully cut about the face, and even the quilted leather pads with which they protect the body are sometimes cut through. It takes very little weight to cut flesh, or any soft substance, if sufficient velocity be given. The cut from the shoulder and fore-arm is most effective upon any hard substance, such as iron, wood, or lead.

To estimate the effect of a sword-cut we will take the formula generally in use for expressing the *vis viva* or force of a moving body, which is, the weight multiplied by the square of the velocity. Assuming this formula (which, however, requires considerable qualification), we will suppose a strong man, cutting with a sword of 4 lbs. in weight, to which he is able to give a velocity which we will call 1. The effect produced we will therefore call 4. We next suppose a weaker man who takes a sword 2 lbs. in weight and able to give it a velocity double that of the first, the effect produced will be equal to 8, or *twice* that which can be exerted by the stronger man using the heavier sword. But let us suppose that the

strong man takes the lighter sword; he will be able to give it a higher velocity, which we will assume to be equal to 3, in which case the effect produced, squaring the velocity, will be 18, or *three* times the effect that is produced by the same sword in the hands of the weaker man, and more than *four* times the effect which he himself could produce with the heavier sword. I merely take this illustration as showing that the force of a blow is enormously increased by increased velocity, but much less by increased weight in the moving body. The nature of the body cut at, however, affects the result very much, but the common error is, that a very strong and powerful man chooses a heavy sword and fancies that he can do more with it than he can with a light one. Because he feels that it requires a greater exertion of strength on his part to put it into motion, he naturally fancies the effect produced will be greater; whereas by taking a lighter sword, to which he can give a higher velocity, he will do better. Of course I do not mean to say that the lighter the sword a man uses the greater the effect he will produce with it, but merely that there is a limit as to weight, which is generally exceeded.

The weight a man can move with the greatest velocity is that with which he will produce the greatest effect, but the lightest sword is not necessarily the one he can move the quickest. It is possible for a sword to be so light that we feel the resistance of the air in making a cut with it, and this is what we express when we say a sword feels "whippy" in the hand. Such a sword is worse than one too heavy.

Another point in a sword is the position of the centre of gravity (fig. 1, C G.) This is not what we generally mean when we speak of the "balance" of a sword, which term is applied to a feeling of the weapon in the hand which results from the relative positions of the centre of gravity and the centre of percussion. The considerations as to the position of these two points would take too long for me to explain to you now. It may be sufficient to say that in light swords these points may be further apart than in heavier ones, that they should be closer in a straight than in a curved blade, and nearer in a thrusting than in a cutting weapon.

We will next examine the sections of weapons used for cutting. These are of course all modifications of the wedge. I have here an illustration consisting of a series of wedges, representing sections of different sword-blades. The first form (fig. 5) is the wedge which would be produced by taking the thickness of the back of an ordinary sword and continuing it in an even line down to the edge. This forms an angle of 9°, which is very much too thin for any practical purpose. We find that a certain thickness is necessary for the edge of any cutting tool. For a very soft substance, as flesh or food, it may be from 10° to 20°, and this is the angle we find in dinner knives, &c. For wood an angle of 25° to 35° is the best, and this is the angle of a carpenter's chisel or plane. For cutting metals or bone the angle required is from 40° to 90°; and, as a sword-blade may meet with substances as hard as these, the least angle which we can give it with safety is 40°. Even this angle will fail against a hard substance if the cut is not a very true one, and we therefore put on a still more obtuse angle, viz., 90° at the extreme edge, as shown in fig. 6, where these two angles are distinguished as the entering angle 90°, and the angle of resistance 40°. You will also see by the outline (figs. 7, 8, 9,) that a

true wedge of 40° would be of such enormous thickness and weight as to be useless for a sword, and we have to find some method of lightening the blade, while preserving the necessary angle of resistance. The following sections of blades show the principal methods of effecting this object. In figs. 9 and 12 the two sides are cut away to a flat surface—this is the general form of the Mahratta or Hindustan tulwar. In figs. 8 and 11, the angle is carried in a curved line to the back, which is made very thin, giving the section a bi-convex form. This is the shape of the celebrated Khorassan, Persian, and Damascus blades generally. Both of these plans give a very strong but heavy blade. The third form Nos. 9 and 13, in which the blade is hollowed into two broad grooves from the angle of resistance, making the section bi-concave, is that adopted in the English regulation sword blade. These drawings being made to scale, you can readily estimate the relative amount of metal in each of them, and you will see that this form gives the lightest blade for a given breadth and thickness. I believe it was this consideration which determined its adoption in the service; but it is not by any means the strongest form, and there are other technical objections to it which I will not enter into.

Nearly all the other forms of blade are also grooved, as you will see, though in a different manner, and I should here explain a peculiar function of the groove which renders it of great use to us. One of the most important requisites in a sword-blade for real service is *stiffness*. There is no possible use of a sword in cutting, thrusting, or guarding, in which too great flexibility would not be a disadvantage. It is a singular illustration of the little attention paid to this subject in England, that this very *defect*, flexibility, is frequently assumed as the criterion or test of a good blade. The blade which springs the most easily, is called the best; whereas nothing is easier, by making the blade thin enough, and useless enough, than to produce a sword which shall bend twice round the hilt and go into a hat-box, or clasp hilt to point and form a waist-belt—both of which wonderful swords I have myself made. The error arises from confounding flexibility of the blade with elasticity of the steel—the latter is necessary, the former useless and always injurious. But to resume: a blade which has been ground thin to lighten it, will frequently be too flexible and whippy. In this case by putting a groove on each side (see figs. 13, 14, 17,) we not only make it still lighter, but we also make it *stiffer;* for if we apply any force to bend a grooved blade sidewise we meet with the greatest amount of resistance which any mechanical form can supply. We are, in fact, bending an arch inwards upon its crown, and of course the deeper the arch the greater the resistance, which explains why the narrow groove in figs. 14 and 17 is preferable to the broader groove of the same depth in fig. 13.

The blade fig. 14, with a narrow groove on each side near the back, is a very old form and a very good one; the weak point of it, that is, the part between the two grooves where the metal is thinnest, is in the best place, viz., near the back, where strength and thickness are of the least importance; in this respect it is superior to the regulation form No. 13. The next blade, No. 15, is rather lighter, but is open to the objection that it has two of these weak places instead of one. The blade No. 16 is better in this respect, it has three grooves, which are much shallower, and the blade is consequently thicker between them. The same remarks

will apply to Nos. 17 and 18, which are sections of the single-grooved and three-grooved claymore blades.

An ingenious method of obviating the weakness caused by deep grooves in a blade is shown in fig. 19, which is the section of a very curious blade made at Klingenthal, the sword manufactory established by the first Napoleon on the banks of the Rhine. In this two very deep grooves are cut in the blade, but not opposite to each other, so that the groove can be made even deeper than the line of axis of the blade. This gives very great stiffness; but I found, on testing it, that it was deficient in cutting power. I may have been erroneous in my judgment, for I was not able to make any very careful comparative trial, but such was my impression, and I could only attribute it to the depth of the groove passing beyond the axis, which might cause loss of power by vibration. Nos. 20 and 21 are experimental blades; the groove in No. 20 is placed at the back so as to preserve the sides of the wedge intact: there was great difficulty in grinding this sword, and the groove being in the back it hardly stiffened the blade at all. The resistance of the crown of the arch was wanting, and the blade sprung almost as readily as a straight sword. No. 21 is another combination which I tried, but, although having some good points, it was on the whole a failure. No. 22 is the old ramrod-back regulation blade, and I believe it to be the worst form of any; the very sudden change from the thick round back to the thin edge, renders it hardly possible to get a blade of equal temper, and the back acts as a check or stop in cutting with it.

There is another curious form of cutting-blade in which the curve is the reverse way to the usual form. Instances of this form are seen in the Khora, and Kookree knife of the Ghoorkas. In tools we have a familiar illustration in the billhook used to lop off small branches of trees, and in some forms of pruning-knives. The Kookree knife is the best known weapon of this kind, and the stories related of its cutting power are very marvellous. If you examine it you will find that the weight is well forward, and in advance of the wrist, and in fig. 4 you will see that the effect of the inward curve is to increase the cutting power by rendering the angle more acute. It acts, in fact, in precisely the same way, but in an inverse direction, to the outward curve in the blade, fig. 2.

Straight cutting swords, of which we have many examples—for instance, the claymore and the old fox-blades of Cromwell's time—are all of them necessarily inferior to curved blades in their power of cutting. They may be made to cut better by the simple expedient of making a drawing or slicing cut with them; this produces in some degree the oblique action of the wedge, which is produced naturally by the curve of the cimeter blade (see fig. 3).

There is another method of using the curved blade, which is in fact a combination of the cut and thrust, by thrusting the edge forwards and along the body aimed at obliquely from point to hilt. It is hardly possible to apply much force in this way on foot, but on horseback, where the horse is moving forwards and supplies the necessary force, it is very effective and difficult to guard.

There is another very curious sword, the Dyak sword, from Borneo; the tassels ornamenting the hilt, which are said to be tufts of human hair, corresponding in number with the heads which have been taken off

by the blade. This sword is broadest at the centre of percussion; the edge leads well forward in advance of the wrist, and, combined with the inward curve (though this is very slight), gives great cutting power to the weapon. In this Mahratta straight sword you will notice how very marked is the throwing forward of the edge of which I have spoken; it bends away in advance of the hilt to an extent of two or three inches. The old light cavalry sword of George III. is an excellent weapon for cutting; light, thin, and very much curved, and with the hilt thrown well forward. In fact this position of the hilt, of which I have endeavoured to explain the reason, may be traced to a greater or less extent in every cutting-sword with which I am acquainted, with only one exception. This single exception is the Japanese sword-blade, in which, as you will see by this specimen, the line of the hilt corresponds with and is a continuation of the curve of the blade. I have not been able to learn any particulars of the way in which these swords are used, but I cannot conceive any method of cutting in which this position of the hilt would be advantageous. Here is another curious illustration of the analogies between the weapons of very remote nations. This wooden club or sword is selected from one of the South Sea Island trophies in the Museum of the Institution, and if I place it side by side with this elaborate steel weapon, the Khora of Northern India (fig. 4), you will see how perfect is the resemblance in shape. The coincidence in every point is too close to be accidental; it is evident that the same principles were present in the minds of the designer of each of these weapons.

I come now to consider the sword as a weapon for thrusting; models of hand-thrusting tools are so numerous that it is difficult to choose from them. The bradawl, the gimlet, the needle, the dinner-fork; any of these will serve for illustration; with regard to the method of their progression they may be considered as a very acute wedge entering obliquely.

The thrust has always been considered in swordsmanship as infinitely preferable to the cut, and the reason is as old as one of the first definitions of Euclid—that "a straight line is the shortest way between any two points." In making a thrust the sword moves in a straight line, and in making a cut it moves in a circle, and of course the thrust is much quicker. You will see in the sketch representing two men in the position of guard, Plate II. fig. 23, that the distance which the figure A with the straight sword has to traverse in making a thrust is less by two-thirds than the distance which the figure B must traverse in making a cut; therefore, if they move with equal velocity, the thrust will reach its mark in one-third of the time, because the one traverses the diameter and the other the circumference of a similar circle.

In figs. 24 to 30 you have various sections of thrusting blades. Fig. 24 is the oldest form, known as the Saxon, or among workmen as the "latchen" blade. You see this form in many of the Toledo and early rapier blades; it consists of two obtuse angled wedges joined at the back, and is sufficiently strong and stiff, but very heavy. Two methods of lightening it by grooving are shown in the next two figures, Nos. 25 and 26. The third (No. 27) is the Biscayan form, with three deep grooves, better known as the French duelling rapier. Technically, either of the former forms is superior to this, as there is very great difficulty in getting these blades straight and of even temper; so much so, that I have never

Fig. 23.

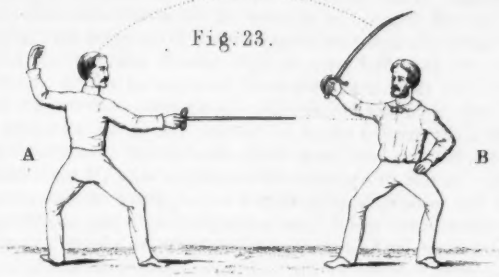


Fig. 24.

Fig. 25.

Fig. 26.

Fig. 27.

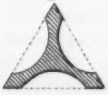


Fig. 28.

Fig. 29.

Fig. 30.

Fig. 31.

Fig. 32.

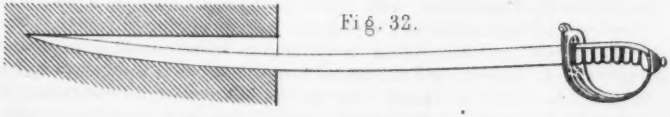


Fig. 33.

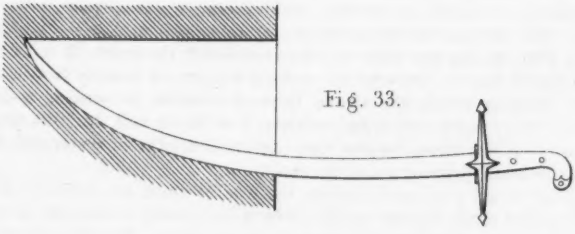
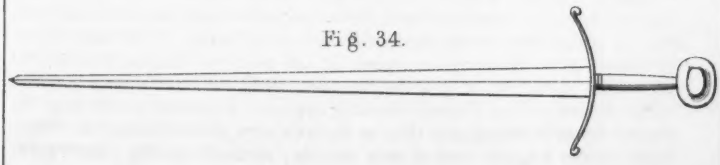


Fig. 34.



J.R.Jobbins.

seen one of these three-cornered rapier blades which was not either soft or crooked. Theoretically, however, the shape is a very good one. Fig. 29 is a section of a very curious thrusting blade. It is probably an experimental sword of the date of 1810 to 1814, and is from the manufactory of Klingenthal. I have seen a great number of these experimental blades, many of which are very curious and suggestive. Here, for instance (fig. 29), is an attempt to give cutting power to a rapier blade, but these angles being very obtuse, have scarcely any effect in a cut. The next, fig. 30, is an improvement on the same form; it cuts much better; but the defect in both these swords is, that they have a tendency to turn over in the hand and to spring at the flat side on the point meeting with the least resistance.

Of course the proper shape for a thrusting sword is pre-eminently straight. As an illustration of the difference in this respect I have a diagram (figs. 31 to 33) showing the effect of a straight thrust into a block of wood with a straight sword, with a slightly curved (regulation) blade, and with a sword of the tulwar or cimeter curve. You see the straight sword moving in a straight line makes a hole exactly the size of the blade; the slightly-curved sword moving in a straight line cuts a hole of about double the width of the blade; but the cimeter blade thrust into the same depth makes a hole five or six times the width of the blade itself, and of course meets with six times the resistance to its penetration. You see, therefore, how difficult it is to use one of these curved blades for the straight thrust. This difficulty probably suggested a method of thrusting which is styled the curved thrust, in which the blade is propelled, not in a straight line, but in an arc of a circle more or less curved to correspond with the blade. The arm makes this curvilinear or cycloidal movement very readily, and it is doubtless the best way of using a curved blade for thrusting at all, but it is open to the objection that the space traversed (as in the cut) is longer than is necessary to reach the object, and that it cannot be used with the "lunge," so as to throw the force of the body into the attack. Like the "thrusting cut," this attack is better suited for horseback than for foot, and in any case it is inferior to the straight thrust. However, this idea of the curved thrust was at one time considered very valuable, and Colonel Marey, of the French army, in an elaborate and excellent work on swords, published at Strasbourg in 1841, went so far as to suggest that the shape of the yataghan, which is excellent as a cutting weapon, and for thrusting can be used with considerable effect in this way, should be adopted as the regulation Infantry sword. It was adopted and tried to a certain extent in the French service, and finally, just as the French were beginning to abandon it, it was adopted partially in England. It is the parent of the present short Enfield sword bayonet, and, as you will see by comparing the two, it has been cleverly modified so as to lose all the distinctive excellences of its original. The beautiful curved line of the yataghan, so accurately coinciding with the motion of the wrist in cutting, is completely lost, and it is applied to the worst possible use in being placed at the end of the gun, where the weight forward, which is so valuable in cutting by the hand, renders it, when placed upon the gun-top, heavy and unmanageable. It is very much inferior to the ordinary bayonet, and it has frequently caused surprise how it came to be adopted here. The reason is simply that it had been tried in France. It has now been abandoned there, and I imagine that we shall

soon have to abandon it in the same way, as it is vastly inferior as a thrusting weapon to the ordinary bayonet, and the power of making a cut is poorly purchased by the loss of all manageability in the arm.

The only other point we have to consider is the sword in its use for guarding. In considering this point we must recollect that guarding is very rarely practised in Eastern swordsmanship. The Eastern soldier is taught to use his sword as a weapon of attack only, and is well provided with steel gauntlets, helmet, and shield to resist a cut. He is therefore contented with a very small guard to his sword, and prefers what we consider a very top-heavy "balance." But we have to contrive a sword that shall be useful in guarding as well as in cutting or thrusting, and to do this we must modify it considerably. The best cutting sword, if it were not necessary to "recover" to guard with it, would be the axe, and the only reason why we want it modified into the form of a sword at all is, that we may be able to use it to defend ourselves as well as to attack our adversary.

The "balance" of a sword, of which I have spoken, is essential for guarding, and for guarding only. The stiffer and heavier a blade is, the better is it adapted for both cutting and thrusting, and it is only when you want to "recover to guard" that it becomes necessary to have it light or elastic. In the old Highland claymore you will find the hand so cramped that it is not possible to form a guard with it truly and readily; this is explained by the fact that the claymore was not used for guarding. The defence of the Highlander was entrusted to the dirk and target on the left arm.

The principal requisite for a good hilt is that it should have as much guard as possible without cramping the hand. The claymore, as I have said, is deficient in this respect. In the Eastern cimeter, which is not intended for guarding, the only protection to the hand is a simple crutch. Most modern swords are defective in the hilt. The Light Cavalry regulation sword has a very bad guard indeed. There is no protection against a thrust, and the whole inner line of the wrist is exposed. The whole weight being on one side of the blade, it has a tendency to turn over in that direction, and in using it you have to exert and waste a certain amount of force to overcome that tendency. The regulation Infantry sword has a much better guard, but it is defective on account of the metal of which it is made, which is liable to be cut through or broken by a fall. The Engineers' is a very good guard, as is also the heavy Cavalry, but both have the defect of being over-balanced, *i.e.* heavier on one side than on the other. A sword I have lately made for India is free from this defect, as the sword will really balance along the edge, the guard being equal on each side. It is only fair to say that this hilt was suggested to me by the straight Mahratta sword I have so often referred to. You will doubtless be amused at me when I say that this sword shows more thought in the contriver than any other with which I am acquainted, and the swordsman may obtain many useful hints from it. Here is an officer's regulation Infantry sword of twenty or twenty-five years' ago. It is a specimen, I believe, of the worst possible arrangement of hilt, blade, and shape, that could possibly be contrived. It is crooked, but has no regular curve; is wrongly mounted for thrusting and wrongly shaped for cutting. The hilt is so flimsy as to be no protection for the hand, and it is made of bad

metal badly tempered. If you ask me how such a model came to be adopted, I can only answer by a supposition. At that time the three principal purveyors of swords to the British army were a tailor, a gold-laceman, and a hatter. I can only suppose that the tailor was the first consulted; if his production was unsatisfactory, the pattern was referred to the laceman; and finally the hatter was called in, who put the crowning touch to the whole.

There are some very curious old swords, both European and Eastern, which I dare say most of my hearers have met with, in which the back of the blade is made hollow, and mercury, placed in the hilt, is carried towards the point in cutting, thus adding to the force of the cut. You will see at once that, though this added to the force of the blow, the additional weight rendered the sword topheavy, and told against the swordsman, if his cut were parried and he had to recover to guard himself. In the same way some of the German headsmen's swords were made with a ball of steel to slide down the blade and add increased force to the cut. Here is a curious instance of what I mentioned to you with regard to the effect of over-weighting. It is a sword weighing 6½ lbs.; it originally weighed 9 lbs., but has been considerably lightened. It was made for an officer in a cavalry regiment, who thought it would strengthen his wrist to use it in post practice. The result is that no living man can cut with it. You can lift it up, and let it drop on any object you please, but beyond this you cannot go. The weight is so great that it is impossible to give it any velocity, and its cutting power is therefore nil. A very simple test shows this. It is easy enough to cut a copper penny in half by a quick blow with a bowie or hunting knife. I have tried to do the same thing with this sword, and hack and hammer as I may, I cannot get it to go through the penny. With the knife I can give a high velocity; with the sword I can give none at all, and so I can do nothing with it.

I think these are the only points to which I have to call your attention, and, as I have already detained you beyond the allotted time, I will conclude by thanking you for the kind attention with which you have listened to me.

The CHAIRMAN.—I am sure we are very much obliged, Mr. Latham, for the interesting and instructive lesson which you have given us. I thought it was a very dry subject, and was not at all prepared for anything so interesting or instructive as this. It shows that you have thoroughly studied the subject, and have made yourself completely conversant with it.

CAPTAIN BURGESS.—Will you kindly make a few remarks upon that curious sword of the time of Edward III.? (Plate II. fig. 34).*

The CHAIRMAN.—You might tell us what was the effect of that heavy sword upon the wielder's wrist.

Mr. LATHAM.—I believe he found he could not use it; in fact, that he could hardly lift it, or make a cut with it. I ought to have made a few remarks upon this curious old sword. You will see from its tremendous weight that it was intended for a time when swordsmen had to deal with iron-plated men, as we have with iron-plated vessels, and you see how they solved the very question we are debating now. They got the heaviest weight they could, and they put as much force behind it as they could

* Bequeathed to the Institution by the late Walter Hawkins, Esq., F.S.A.—Ed.

possibly give—exactly the same thing we are now doing in our experiments with artillery against iron-plated ships.

Captain SELWYN, R.N.—There are one or two questions I wish to ask Mr. Latham, for the benefit of the naval branch of the profession. One is, whether it has occurred to him that the use of the heavy knob on the guard in that antique sword, which we have just been looking at, has anything to do with the old term of pommelling one's enemy? As Jack has often been known, in a press of men, after having got up his sword-arm and being unable to get it down again, to use the hilt of his cutlass, and knock his enemy's teeth down his throat; so may not the ancient knight have used that sword to pommel his enemies, after using the sword to cut him down? I would also ask whether his attention has been drawn to the peculiarity of Lord Cochrane's mode of arming his seamen for boarding? He fastened bayonets to their left arms, with the points projecting beyond the hand, and then armed them only with cutlasses, telling them to go and take the enemy. Of course, the bayonet formed a perfect guard, tied as it was along the outside of the arm, with the points projecting about 6 inches. It enabled Lord Cochrane to take the Spanish frigate in the way he did, from under the batteries of Callao. The last thing I beg to ask is, if, by any effort of art, Mr. Latham can give us a weapon which will enable the seaman to feel a little more secure. Seamen begin to feel that they have lost their confidence now that plated ships have come into action. We are in that state, that, with the very hard shells ships have now got, it will be utterly impossible to hope that swords will ever come into play; and, if Mr. Latham can only suggest some means of offence, I think we should be delighted. For the ancients and for cavalry, swords may be possible, but not for seamen.

Mr. LATHAM.—With regard to Captain Selwyn's remark about the pommel of this sword suggesting the use of the term "pommelling," I think it is very likely. It is a happy idea, and there are many etymological derivations much more far-fetched. The idea of strapping the bayonet to the arm was perhaps suggested to Lord Dundonald, who was a Scotchman, by the method of using the dirk with the target. The thumb being placed on the hilt of the dirk, the point projected about an inch beyond the elbow; the target was used for parrying, and the return given with the dirk. I am not sufficiently acquainted with the construction of the new iron ships to give an exact reply to the third question. But, from the accounts we have, it seems to me that the only way to encounter an enemy of this description is to attack him as you would a wasp's nest; smother him by stopping up his funnel and hatches. I am aware that a lecture of this kind on the use of swords may seem to have more of an antiquarian than of a practical interest in the present day. At the same time the sword is the *ultima ratio*—the best weapon for hand-to-hand encounter, and to hand-to-hand encounter it must come at last. If we go on improving our armour at such a rate that we cannot hurt each other while we keep within our vessels, the only means of deciding the question will be to come out of them; and this may lead to the old system of man to man being revived, and the shape and use of the sword become again a subject of some importance even in naval warfare.

PRESENT CONDITION OF OUR CAVALRY; WITH SOME SUGGESTIONS AS TO THE PRACTICABILITY OF INCREASING ITS EFFICIENCY IN THE FIELD.*

By Major Alfred Stovell Jones, V.C.; D.A.Q.M.G., Cape of Good Hope.

While the Artillery and Infantry of all armies have passed, during late years, through the most extensive changes in organization and equipment, and engineers have modified the arrangements of defence to meet these changes in offensive warfare, the Cavalry service has alone stood still, or nearly so, when its progress in the march of improvement is compared with that of the other arms.

It is true that the Emperor Napoleon is understood to have turned his attention to Cavalry at Chalons, and that a commission has been sitting for some months at the Horse Guards to consider and report upon our Cavalry; but, in the first place, it will hardly be creditable to us as a nation if we allow the French to show our Cavalry the way; and secondly, we shall be expecting too much from our authorities, if we leave to them the task of originating or inventing the required improvements.

The authorities at the Horse Guards and the War Office did not invent the Enfield rifle, or the Armstrong gun; they confine their attention to their own province, consider the merits of proposed improvements, and adopt such as they approve.

It is the object therefore of these pages to draw the attention of Cavalry officers and others to two questions which are constantly occuring to the mind of every one who looks forward to the prospect of future wars.

1st. Will Cavalry, equipped and organized as at present, retain the same high relative position in future wars which it has held in past times?

2nd. If not—what changes must be introduced in order to restore in favour of Cavalry the balance against rifles and rifled cannon?

Let us consider the first question with reference to the duties of Cavalry in the field as enumerated below.

Heavy Cavalry	Charge against Cavalry.	Light Cavalry	Outpost duty.
	" " Infantry.		Reconnoitring.
	" " Artillery.		

In the first division of Heavy Cavalry duties, viz., the charge against Cavalry, the conditions are what they have always been, and victory will remain with that side which can bring up the last reserve, rides harder, has better bred or more powerful horses, or which is led by better officers, than the other.

One or a combination of these advantages may carry the day, but, alas! how seldom is an opportunity for this glorious duel afforded by modern warfare.

* Communicated May 29, 1862.—Ed.

In the second and third divisions of Heavy Cavalry duties, however, the case has been materially altered, to the disadvantage of Cavalry, by the introduction of new weapons, and improved projectiles, inasmuch as Infantry and Artillery are no longer nearly harmless at 200 and 400 yards distance respectively, as formerly the case.

The details of both Artillery and Infantry rifle practice are too well known to need more than a simple reference to them here in support of this conclusion.

It is true that the superior precision and range of the modern rifles and shells will not be felt very much in the actual advance to the attack by Cavalry charging Infantry or Artillery, because the necessity for constant re-adjustment of sights and time-fuses will nullify their effects upon a rapid advance; but no extensive formation or deployment of Cavalry can take place under a heavy fire of segment shells and conical bullets.

It appears certain, unless some peculiarly advantageous ground permits the formation under cover within reach of the enemy, that the Cavalry must advance in line over far too much ground to admit of its preserving anything like steadiness in the attack; besides which, the intended point of attack, and probably also the whole force, and reserve, prepared for the charge, will be patent to the enemy in time to enable him to concentrate his force on the menaced point.

This leads to the conclusion that, for the future, Cavalry must be banished from the first line—it must be kept strictly under cover in the second line, until an opportunity occurs for employing it in actual collision with the enemy, and must then be brought rapidly up and formed on the move. Its very existence will depend upon its mobility. How far this essential quality is compatible with our present equipment and system of drill, is known to every one who has endeavoured to get the simplest manœuvre of the drill book performed with the requisite steadiness on the move by even one squadron, amidst the noise and confusion of action. Impatient men and fretful horses in the rear rank, and the plunges of wounded ones in front, together with the loss of telling-off consequent upon casualties, are formidable obstacles to a steady formation, and often occupy the attention of the leaders, at the time when it is equally necessary for them to be watching the enemy.

So much for the prospects of the Heavies in future campaigns; let us now turn to the Light Cavalry, and see how the case stands for that branch of the service.

The duties of outposts and reconnaissance are among the most important of those for whose performance a general in the field has to provide, and hitherto, whenever the country has been even moderately open, these duties have been for the most part performed by Light Cavalry.

The daily comfort of an army during the whole campaign, as well as the success of every enterprise, is so dependent upon the manner in which these duties are carried on, that it would surely be advisable to equip and organize the force to which their performance is entrusted with a view specially to those duties, and not to expect it to undertake, or be prepared for, other duties which demand different qualifications.

Heavy Cavalry for the charge should be organized on the principle that each squadron be considered as a living projectile, which must be carefully

preserved in condition and weight, until the moment at which it is to be hurled against the enemy: every thing should be done to consolidate and bind it together; it should be nursed as much as possible, and be brought into action in the very highest state of efficiency for one short gallop. One discharge of such projectiles, launched at the right instant, may change the fate of a battle, or complete the destruction of the enemy.

Light Cavalry, which, on the contrary, is valuable in proportion to the individual excellence of its men and horses, should be composed of short, active, and intelligent men, mounted upon wiry enduring little horses, and trained with more individual self-reliance, to take their own line across country, jump or creep wherever their horses can live, rally for a short rush, or disperse and baffle their pursuers by flight wherever they appear too numerous, but always ready to return to the worry when a chance is open to them.

We know that division of labour is productive of greater efficiency in every trade, and it seems impossible that the same men and horses can be trained to the performance of duties so much opposed to each other as those above described, with any prospect of combining the highest state of efficiency in each; nevertheless, in our service it has been ordained, from motives of economy, that the Light Cavalry shall be equal to the charge in line.

The result of this policy has been, as might have been expected, that we have sacrificed complete efficiency as Light Cavalry to gain a measure of success as Heavy; and, though in all former wars this makeshift for a perfect Light Cavalry has done the work required of it, and has beaten the best Heavy Cavalry that could be brought against it, yet this success has been due to national advantages rather than to the system itself. We have beaten our enemies because our Cavalry was made of better stuff than theirs, rather than because we had cut it out in better fashion.

In former wars Light Cavalry could gallop up and establish its outposts, without much risk, within some 200 yards from those of the enemy; but in future it is to be presumed that he will have at least some rifles on his advance posts, which will demand respect at treble that distance.

The difficulty of obtaining information was always great, but what will it be in future?

It appears that it will be difficult for our present style of dragoon to approach near enough to the enemy even to ascertain the direction of his line of outposts, and he will have little chance indeed if he ventures, as he used often to do, within that line, trusting to the speed of his horse for escape in case of being viewed.

In future, outposts will probably be formed by troops organized and equipped to seize and maintain positions by long range and accuracy of fire.

Our cavalry are to be furnished with breech-loading rifled carbines and rifled pistols; but there are some very serious objections to this sweeping change.

1st. It will be impossible to teach cavalry as a body to make anything like decent practice while mounted.

What a ludicrous exhibition is always made when Cavalry send out their skirmishers, nine out of ten of whose horses feel like fish out of water

until they rejoin their squadrons; many of them are seen to wheel about, or at any rate throw up their heads and jump at every discharge of their riders' firearms, and some even can hardly be induced to leave the ranks until long after the sound for "skirmishers."

2nd. All officers who have served with Cavalry in the field, will allow that the men are far too fond of applying to their carbine buckets and holsters, even when they know, or ought to do, that the arms they contain will hardly hit a haystack, and there is surely some reason to dread that this tendency of the Dragoon to place too much reliance on his firearm will be increased by supplying him with a superior weapon of that kind.

Our present Dragoon can only render himself formidable to his enemies by the speed of his horse, and the lance or sword in his hand.

He must seek to close with his enemy or he will be worthless, for, should he attempt to play at long bowls, he will inevitably find his master at that game. Some few men per squadron might be armed with rifled carbines, to dismount and use them occasionally; but these men should invariably be good marksmen, and men who can thoroughly be depended upon; the rest of the squadron will do much better without any firearms at all, unless they can be trusted with a revolver in their belts, to be used only for their individual self-defence, in case of being dismounted in a *mêlée*.

It is but natural to expect that rifles will in future be used by the advanced guards and outposts of enemies, and such being the case it is hardly likely that a less distance than about 900 yards will intervene between those of two hostile armies.

The best of our Cavalry carbines, however, will range with good effect but half that distance, and, when we consider what a conspicuous target one of our present videttes would make, it appears that our present Light Cavalry must be beaten out of the field by any modern Light Infantry which can be pushed up to the outposts by an enemy.

Thus we arrive at the conclusion, with all due respect to our Light Cavalry, that its right occupation is gone. It, however, having been half organized as Heavy Cavalry, we need not throw it away, for we have not come to the same conclusion with regard to the duties of the Heavies, although, there even, we cannot but recognise the necessity for introducing some changes.

"Tactics," said the first Napoleon "must be changed every ten years;" how much more does the introduction of altogether new weapons appear to demand a change of organization and equipment!

Before such deep radical changes as those which appear desirable (if the above is a fair statement of the prospects of our present Cavalry) can be safely introduced, there should be a wide-spread conviction, gradually diffused through the whole body which is to undergo change, that such change is necessary.

No healthy reform can be introduced from without, before the necessity for it has been recognised from within, for there is a rooted conservative feeling in all human nature, which rebels against change, silently it may be, but often so effectually as to nullify all good which might have resulted from a willing response on the part of subordinates to the noblest designs of their superiors.

It is in the hope of contributing in some degree to this preparation for reform, that we have opened this subject, and, since writing the above, we have noticed with pleasure a review of, the work of Colonel D'Azemar, entitled "The Future of Cavalry," in the U. S. Magazine.

This shows that the subject is in course of ventilation, and it is our firm conviction that Cavalry will eventually recover its relative position to the other arms.

It may require a campaign or more to bring about this result, but the earlier we recognise the necessity for change, the more time we shall have to consider and mature the means of introducing it; let it be done, if possible, gradually during peace, rather than hastily in war.

Having now adduced what appear to us valid arguments for replying in the negative to the first question we proposed to ourselves, we will pass on to the second, which is by far the most difficult part of the subject, for it is one thing to find fault with a system, and altogether another to propose one which shall work better. The one is constantly done and often reasonably, but the other, seldom, if ever, with complete success.

We will do the best we can, however, and perhaps our example may induce others to come forward to correct our errors, and make their own suggestions as to "what changes must be introduced, in order to restore the balance against rifles and rifled cannon."

In the first place, then, it follows, from what has been said about the duties of Heavy and Light Cavalry, that the distinction between these two branches of the service, at present only nominal, should be revived in full force.

Let us consider how each of these arms may be reorganized, with a view to giving each of them the highest possible qualifications for its own peculiar class of duties.

First, then, for Heavy Cavalry; "mobility" is the great desideratum. There is no doubt that having good leaders, and plenty of them, is a principal element of success in Cavalry action: without them the best Cavalry become like a flock of sheep. Every man in a squadron should be under the eye and within the reach of its leaders.

Our present system places one half of the men in a rear rank, where they are quite out of reach, and we have to place serrefiles, when we have them, in a third rank, to watch and control this rear rank, which has been alluded to above as useless, and prejudicial to the free working of the front rank. On a peace field-day the serrefiles, with the assistance of troop and regimental sergeants major, and the adjutant, may succeed in keeping some order in the rear, but on service their assistance is rarely available. The objection to Cavalry rear ranks has been recognised for many years by some of the best Cavalry officers, and the system of rank entire was adopted with great success by General Bacon in the Portuguese service, in 1833, and following years. General Bacon had many supporters, and much was written in favour of his system, both at the time he adopted it and in 1854-5, when Colonel Beamish published his remarks, "Uses and Application of Cavalry in War," with copious annotations; yet, as Lord William Russell says, in one of the letters published in that work, "the Duke of Wellington is in our favour, but the prejudices of Cavalry officers

are difficult to overcome," and the old system stands its ground. Some of the remarks of the late Duke of Wellington, upon using Cavalry in rank entire, are so pertinent and conclusive in favour of the system, that we cannot resist the temptation of quoting the following extracts from his Grace's letter to Lord William Russell, published in full in Colonel Beamish's work.

"The rear rank does not strengthen the front rank as the centre and rear ranks do the front rank of the Infantry. The rear rank of the Cavalry can augment the activity or even the means of attack of the front rank, *only by a movement of disorder.*

"If, then, the attack of the front rank should fail, and it should be necessary to retire, the second or rear rank is too close to be able to sustain the attack or to restore order.

"The second rank must be involved in the defeat and confusion, and the whole must depend upon some other body, Cavalry or Infantry, in reserve, to receive and protect the fugitives.

"I have already stated that the second or rear rank can augment the means of the first rank only by a movement of disorder; this is peculiarly the case if the attack should be successful. In all these cases, the second rank, at a distance sufficiently great to avoid being involved in the confusion of the attack of the front rank, whether successful or otherwise, could aid in the attack, or, if necessary, cover the retreat of the Cavalry as a body, while, by the absence of all impediments from the closeness of the rear rank, the activity of the front rank would be increased.

* * * * * *

"I conceive that the one-rank system would require a change, not only in the discipline, but in the organisation, of the Cavalry. If I am not mistaken it would render the use of Cavalry in an army *much more general than it is at present.*"

The Cavalry Brigade at Umballa, in India, was manœuvred on the system of rank entire by Colonel Grant, now Sir Hope Grant, K.C.B., in the years 1855-56, and, in spite of the disadvantage that the second line was only formed on the parade by increasing the distance of the rear rank of each squadron, and placing officers and non-commissioned officers in front of it as squadron and troop leaders, instead of being composed of distinct squadrons, as it would be if the system were fully adopted, it nevertheless appeared to work well.

Subsequently, in the operations before Delhi, the officers of the 9th Lancers, who had profited by the lessons learnt at these field days of the previous drill season, found several opportunities of employing the rank-entire system before the enemy. On one occasion, 4th July, 1857, it fell to the lot of one squadron, 9th Lancers, to have to cover the retreat of a small force of Infantry which, overpowered by numbers, had orders to fall back across a mile or so of open, to cross a bridge, and then defend a canal until reinforcements could arrive.

The squadron, formed in the usual manner, was hard pressed by a large force of the enemy's Cavalry, whose front was covered with skirmishers, who threatened, by out-flanking the squadron, to cut it off from the bridge.

The officer in command of the squadron, seeing his danger, hit upon

the plan of deploying its rear rank to form a second squadron, and extend his front; this move had a visible effect in checking the enemy, and he was then able to retire by alternate squadrons, at the walk, until he reached the bridge, just as the last man of the Infantry had defiled across.

A few months later, the same officer had cause to regret that the system of rank entire was not in force, when, having to form a troop of 23 men only from single file, in front of two squadrons of the enemy advancing at a trot to attack him, he had not time to get even this small force into a single rank, and was consequently obliged to perform his charge in two ranks against the leading squadron of the enemy, when it outflanked his troop by more than two-thirds its front.

It may be objected that the weight of two ranks was not so necessary in the cases above cited as it may be in others, but then we would respect the words of the Iron Duke that the rear rank can only aid the front rank by a movement of disorder, and would be more usefully employed if brought up under its own leaders to succeed the front rank in its career.

If, however, weight is desired, the second line of rank entire squadron may be brought up to half a horse's length at the moment of action; its leaders moving out to the flanks.

There are two other impediments to mobility in our present system, viz. pivot flanks, with all their attendant evils of inverted lines and the movement by threes.

Nothing can contribute more to mobility than simplicity of drill, and nothing can be more complex than our system of pivot flanks, a due attention to which must occupy every faculty of Cavalry leaders, and leave them little leisure to look out for the nature of the ground and the condition of the enemy, which are all-important points.

In the movement by threes, as 12 inches only is allowed from nose to croup, opening out is almost inevitable, and the squadrons thereby lose their solidity; the closing in to dress, thereby rendered necessary when the squadron is fronted, appears to us a far greater evil than the appearance of daylight, which is urged as an objection to rank-entire squadrons.

In forming threes on the halt to a flank the reining back of the flank horses, particularly in deep ground, is apt to produce vice by unnecessarily irritating the animals, even when their riders have good hands, which is an unusually favourable condition.

Having stated the above objections to our present drill, we will proceed to suggest a few principles upon which a new one might be built up.

1st. Let the regiments be sized, as to men and horses, by squadrons, each squadron being of the ordinary strength of a troop, with one additional lieutenant.

2nd. Form the squadrons in rank entire with their own captains and lieutenants as leaders, placed, as at present, half a horse's length in front.

3rd. Number off, and let the rank consist of a number divisible by 8, *i. e.* be 24, 32, 40, 48, 56, 64, 72, &c., &c., the odd, 1, 2 . . . 6, 7 men, if there be any left over, forming a second supernumerary rank, to ride in rear of the squadron under charge of the serjeant-major, and fall into the rank one by one as casualties occur, to keep up the charmed number divisible by 8.

4th. Divide each of the squadrons into two troops of equal strength, and tell them off by *fours* from their inner flanks.

5th. Make any number of complete "fours" which is nearest the half troop, into divisions (either flank or centre divisions may be the strongest.)

6th. Let the fours wheel invariably forward on the horses of the named flank.

The arguments in support of these principles are briefly as follow:

1st. The regiment is sized by squadrons, in order to make the parts of each perfectly interchangeable, so that it may be indifferent what part of the squadron any man and horse may be placed in.

2nd. The advantage of keeping each squadron always under its own officers, both in the field and for interior economy, must be self-evident, and needs no remark.

3rd. The adoption of these numbers for the squadron seems desirable in order that each troop may be composed of an equal number of complete fours. The parts of the squadron may then be wheeled about in any manner, and still retain the telling-off by fours intact until casualties occur; these can be filled up at once by a man from the supernumerary rank moving up as a stop-gap while any of that rank remain, and, when it is expended, the squadrons can be re-told off on the same principle as at first, the seven men rendered supernumeraries reining back accordingly.

4th. The superiority of "fours" over "threes" for the flank movements of Cavalry consists in the greater freedom of movement gained by allowing 1 yard from nose to croup, instead of 12 inches, which is the theoretical distance allowed in "threes."

Practically, indeed, a column of threes always opens out more or less on the march, from the difficulty of keeping horses up so close, and when fronted closing must ensue; whereas in fours, since a horse is about 8 feet long, and 4 horses in line show a front of 12 feet, when wheeled into column, there is a theoretical distance of 4 feet available, which allows a margin of 1 foot to spare, when the rule of 1 yard from nose to croup is observed. Another reason for objecting to such a close column as that of threes, is the liability to accidents so often incurred, from horses treading on the heels of those in front of them.

All wheels of fours being performed on the flank, it is only necessary for the flank men of each four (that is, those who number off 1 and 4) to remember their telling-off, because the wheeling flank man brings the two centre ones round with him. The flank fours of divisions can easily remember that they are such, and this is all that is required of the men in the ranks.

This system of "fours" has been tested, and is in practice, in the French Cavalry.

5th. It will be observed, that, as the proposed divisions will not be necessarily of equal strength, there may be overlapping of some divisions over others when they are wheeled into column, but, as it is provided in the 5th principle that the divisions shall consist of numbers of complete "fours," as nearly as possible equal to the numerical half of the troop, it is evident that no division in a squadron can exceed any other by more than four men.

Instead of the old rule of "when right is in front, left is the pivot," we

propose the general one, "that covering be preserved by that flank on which the wheel into column was performed, until it is ordered to be changed."

The necessity for regarding pivot flanks having passed away with rear ranks, and squadrons which can be clubbed by putting the proper right troop on the actual left of the squadron, it at once follows that a column may be wheeled into line indifferently to either flank as required; in ordinary circumstances perhaps it would be well to order the covering to be changed, a few seconds before wheeling into line to the other flank, and upon such a caution the leaders of weak divisions (the case of a column of divisions) would incline to take up the new covering, in order to ensure a steady wheel; but such change of covering is by no means necessary even in a column of unequal divisions, for the wheeling flanks of the weak divisions will come round more quickly than those of the stronger ones, and they will have time, after completing their own wheel, to move steadily up into line with the stronger ones, as quickly as the latter can complete their wheel.

The distance they would have to move up being only four yards, this can hardly cause any great unsteadiness, and, as has been said before, it can be avoided altogether by changing the covering a few seconds before the wheel.

It is well known that the advance in line is the most important movement which Cavalry can have to perform; all other movements are preparatory to it, and lead up to this final advance, which is to end in the decisive charge, the failure or success of which principally depends upon the order and regularity of the line at the moment of impact upon the enemy.

The preservation of order up to this moment is the hardest duty that squadron and troop leaders have to perform; the squadron leader especially should have a steady horse well in hand, and it is essential that the centre man of the squadron follow his lead faithfully and steadily, at half a horse's length distance; but when a rear rank is pressing upon his horse's tail, and a horse edging up against his thigh on either side, it is often more than this man can do to avoid treading on his officer's horse's heels, and thereby rendering him hopelessly unsteady for that day at least, if not for the rest of his life, as a charger.

The abolition of rear ranks would most materially diminish the embarrassments of this hardly-used and valuable soldier, whose duty after that of the squadron leader is certainly most important to the welfare of the squadron; but, as his duties will still be most important, it is but reasonable to pick for this place the best rider of the squadron, and mount him on the steadiest horse.

In the interchangeable squadron we have described above, we would place him between the two troops when the squadron is in line, and make him quite independent of its telling-off.

When the line breaks into column, this man or non-commissioned officer (as he will possibly hold the rank of sergeant) will move independently and take up the position of squadron marker, whose duties he can always perform, and, when line is re-formed, he will come up to his original place, which will be kept vacant for him by the flank men of troops.

On the wheel about by "fours," he will move out to the front, and turn about to resume his post in the ranks, and lead the line to the rear, when it is ordered to retire.

A regiment of the present establishment, formed on the principles above sketched out, would parade in two lines of four squadrons each, at a distance, generally speaking, of the front of a squadron, and an interval between the lines.

The second line would be commanded by the major, to repeat the words of command, which may be the same for both lines.

Every movement from line into column (open or close) could be performed upon any named point with the utmost celerity, and the column would deploy or form line by the command, "To the right or left of the front ———" as desired.

The simplicity of the proposed system of drill consists in this: that neither officer nor man is burdened with a string of things to be remembered, and therefore everybody's wits are available for more important employments.

After any change in the order of squadrons, the leaders will number off without word of command, and then if the men who are flanks of troops, divisions, and fours, can only recollect that they are such, and know their right hands from their left, there is no more to be thought of, and there can be no excuse for the slightest confusion.

Such is the outline of changes we propose for giving mobility to Heavy Cavalry, and if such a system of drill were adopted for all our present Cavalry, heavy and light, the distinction between which, is rather nominal than real, we are convinced that our squadrons could be brought up even to the bayonets of a square, without sustaining much more loss than they were liable to in the days of *Brown Bess*.

How far it is possible for Cavalry to break a square of good Infantry, unshaken by Artillery fire, has been always a disputed point, and all Cavalry enthusiasts, we doubt not, will bear with us while we offer a few suggestions which we trust may tend to set the question at rest in favour of Cavalry in future wars.

First then, such a charge must chiefly depend for success on its momentum, measured, just as that of any other projectile, by its weight multiplied into its velocity. Sir W. Armstrong has succeeded in smashing strong iron plates by increasing momentum, and changing the form of his inanimate projectiles, and let us be encouraged thereby to look for similar results from our endeavours to apply like remedies to the deficiencies which have made our Cavalry break up before the bayonets of a square, as the old shot have done against 4½ inch plates.

The momentum then of a charge being the weight of all the men and horses who are effectively employed, multiplied by the speed at which the squadrons are moving at the instant of collision, it could be increased by augmenting either of these terms, the other remaining the same or being also augmented. Weight however can only be advantageously augmented by obtaining horses of greater power in muscular development; any other increase of weight will only produce a more than compensating loss of speed. Moreover, it has been found that the breaching power of projectiles is to be measured by their weight multiplied by the *square* of their velocity; consequently, speed is by far the most important term in the calculation, and what is true with regard to the inanimate projectile must be equally so with squadrons of Heavy Cavalry, if rightly employed.

We should therefore endeavour to reduce all that the horses have to carry which does not tend to produce motion, to a minimum, and increase their muscular power to a maximum—accordingly we would reduce the weight of Cavalry men as much as possible. The terms of enlistment should be such, that on a man's attaining a fixed weight (say 12 stone) he should be at once transferred to the Infantry of the Line, unless he were found to possess qualities which were considered to compensate for the evil of his weight.

Men of 10 stone are strong enough, if well made, to manage a horse and to use a lance or sword with effect: every pound therefore in excess of that weight is prejudicial, because it will diminish the speed of the horse. In racing, 7 lbs. is often considered equal to "a distance," and yet we now put more than double that weight in the shape of a valise over the Cavalry horse's loins.

Would it not be better to attach transport, in the shape of a cart or a few bât horses, to each squadron, for the purpose of carrying all in the way of clothes and food required by both men and horses?

The transport could always accompany the squadron until the actual combat, if the Cavalry were properly husbanded and kept out of fire, and then, if the attack should succeed, it would be easy for the transport to rejoin, and, should it fail, the loss of baggage ought to be a small consideration, for Cavalry once sent into action should be considered as sacrificed for ever, unless its attack prove successful. There can never be half measures with such a force as this, and the general who employs it, should be well satisfied that the occasion on which he does so, is important enough to warrant the risk of its total loss, or else he should not send it into action at all.

This is the reason why so few good Cavalry leaders can be found, because the union of caution and reckless enthusiastic energy seldom falls to the lot of the same individual, and the lack of either of these qualities is generally fatal to the other. Caution is most desirable up to the point of engaging the enemy, and then utter fearlessness of consequences must take its place, to carry out the plan which has been carefully matured.

With regard to weapons for Heavy Cavalry, none can equal the lance for general purposes, but it should be backed up by a good cut-and-thrust sword.

Among lances, the Indian hog-spear bears off the palm, from its length and lightness, and is infinitely superior to the new lance lately adopted into our service, whose thrusts can be easily parried. The lance should be well up under the arm, wedged between it and the body throughout its thrust, and, when held in this manner, a round parry, produced by the turning of the whole body above the hips, will sweep down anything the lance may come in contact with.

Lances should be 11 feet long, and with such there can be no difficulty in reaching over the bayonets of Infantry.

If a few of the kneeling rank can be speared, the lances may be abandoned, and the squadron, pressing in with their swords over the wounded men, may soon complete the destruction of the square. We have already pointed out some of the objections to carbines, so far at least as regards heavy Cavalry, so of course we propose to relieve the horses of

this dead weight. If the valises be carried in the squadron cart, saddles may be reduced both in size and weight.

Cruppers, too, may be discarded with great advantage; and after all these changes we may hope to bring our Heavy Cavalry into the field, bearing an average weight of 14 stone per horse, instead of 18 stone 4 lbs. which is now the average of our Light Dragoons.

The increase of speed which we might look for as the result of such a reduction of dead weight would vastly increase the momentum of the charge, and the saving of muscular power which is now expended in bearing it through a long campaign, and the immunity from sore backs, will be found even more valuable than this.

We now pass on to the changes we would propose should be adopted for Light Cavalry, or rather to consider how such a force may be produced in a state of efficiency, fully equal to compete with any light troops armed with rifles, which may be brought against it.

In the first place then, the Light Cavalry, *par excellence*, should be brought to regard their horses chiefly as means of rapid locomotion, not as fighting animals. The men should be light, energetic, quick-sighted, and, above all, good marksmen. They should be armed with the best breech-loading rifle, with sling, and sword bayonet, and they should ride active, wiry ponies, trained to stand rooted to the spot when the riders dismount.

There are plenty of shooting-ponies in South Africa which answer to this description; they can gallop safely with loose rein over any ground, and will pull up short, and stand without moving a muscle at a touch of the reins, while their rider takes his shot from their backs, or dismounts if he has time to do so. These ponies require but little forage beyond what they can pick up for themselves, when they are off-saddled and knee-haltered.

They are seldom shod, never kick, and when knee-haltered may be safely trusted not to wander many yards. This means of securing horses is very simple and convenient, consisting in attaching the head-collar to the fore-arm, a little above the knee of the animal, by a rein or collar rein of untanned leather.

The Light Cavalry ought to be organized upon the same principle as the Irregular Cavalry of India, and the Frontier Mounted Police of British Kaffraria, viz. by paying each man a daily rate of pay, which shall enable him to keep himself and his horse, and this species of Cavalry can be maintained by such means on far cheaper terms than our present Light Cavalry, as has been proved wherever the plan has been tried.

The man should be compelled on enlistment to bring with him an animal in every way up to the mark, and from that time forward to keep him in a fit state for any service, on the condition that the Government shall pay him a fixed rate of compensation for any loss of the horse caused by the requirements of the service.

The advantage of having men of a certain position, who have an interest in their horses and arms given by the possession of actual property, would be great, and the control of their officers over such men, provided the former are carefully selected, and entrusted with full powers to stop pay and discharge men at pleasure, must be very great, and easily exerted; while the simplification of accounts and money matters, when all commissariat and clothing arrangements are left to individual care of the

men, will give greater leisure to the officers, and enable them to devote all their energies to more important duties.

The Frontier Mounted Police of British Kaffraria are paid at the rate of 4*s.* 3*d.*, to 4*s.* 6*d.*, per diem, out of which they provide every necessary for themselves and their horses, and on these terms the cost of each man, including pay of officers, &c., amounts to about £87 per annum.

The force of Light Cavalry with an army, if confined to its distinctive duties, need never be very strong, and as it will always be employed on the outposts, and in advance of the army, it could safely be abandoned to its own resourses without danger of starving itself, or of materially interfering with the commissariat arrangements necessary for the support of the rest of the army, which is compelled to move in masses.

Every third or fourth man might bring into the field a second pony, in all respects like the one he rides, but carrying a pack-saddle, to be loaded with what little food and clothing may be required for his squad. This second animal would be his own property, and he would receive additional pay for its sustenance, so long as it may remain fit for work. The squads should be encouraged to consider their interests bound up with this beast of burden, and to be as accommodating as possible to one another; but, if disputes should arise, each man must be limited to a small fixed weight, and not be allowed to place any more than this, on the pack-horse, or to carry anything on his own riding-horse.

The habits of independent action and foresight which such a system would generate in the force employed on the outposts must prove invaluable to the Army, which depends upon its outposts for warning of the approach of the enemy, and for that knowledge of his force and movements, which should govern every order which it receives.

Having thus sketched out the changes we deem indispensable to restore to Cavalry the high relative position with regard to the other arms, of which the general introduction of arms of precision has temporarily deprived it, we would, for the sake of clearness, briefly recapitulate them before closing this paper.

1st. Reconstruct the whole mounted branch of the Line under two distinct classes of Heavy and Light Cavalry, or, more properly speaking, of Cavalry and outpost troops.

The changes recommended for the first class are:

1st. Simplicity of drill, by discarding rear ranks and introducing the formation of "fours," &c.

2nd. Reduction in weight carried by the horses, to be brought about by altering the terms of enlistment, abolishing carbines, valises, and every unnecessary part of the horse appointments, &c., &c.

For the second class, or outpost troops:

1st. Special organisation for these duties, which are to be performed chiefly on foot, the horses being only intended to give facilities of rapid locomotion, and to bring the men fresh and cool to the decisive point.

2nd Selection of the men as light, active, good marksmen: and—

3rd. Simplification of interior economy and commissariat to give the utmost mobility to this force.

RIFLE TRAJECTORIES AND RIFLES.*

By Arthur Walker, Esq., 79th Highlanders, Lieutenant Instructor, School of Musketry, Fleetwood.

Until the last few years the small-arms practice, so called, of the British army has been a farce; it is notorious that not one man in a thousand of Wellington's troops had ever learnt to shoot, and it was held that of every 250 bullets fired, 249 were thrown away.

The modern improvement in small arms has however changed all this: the Rifleman of 1862, dealing death at a distance of 1,000 yards, is a very different being from the soldier of 1800, with his musket killing once out of 250 times at a distance of 100 yards, and the improved weapon of our day has, at a minimum calculation, rendered the fire of infantry soldiers fourfold more effective than it formerly was; *always provided*, however, that the training of the soldier in whose hands this weapon is placed, has been such as will enable him to elicit or develope its full power; for, whatever the range and accuracy of a rifle may be, it obviously loses very much of its value and scope if placed in the hands of a man unskilled in its use. For, just as highly improved machinery involves increased intelligence on the part of the mechanic and engineer, and as the introduction of steam-ploughs and reaping-machines in farming necessitates a superior description of agricultural labourer, so in like manner the introduction of the rifle into our service demands on the part of the soldier a certain knowledge, which can only be imparted to him by means of a special training; to place the rifle of the present day in the hands of the "pipe-clayed automaton" of former days, would be an anachronism and inconsistency.

In this course of musketry training, there is perhaps no portion of it more absolutely essential to men armed with the Enfield rifle than "judging distance." For the most part we are too apt to rest satisfied with becoming tolerably good shots, at targets placed opposite us, at fixed and known distances, forgetful that in the field of active service—which after all is the only proper medium through which to regard the efficiency or non-efficiency of the rifleman or soldier—unless he can at least judge the distance at which the enemy is from him with a certain proximate accuracy, and adjust his sight accordingly, he might almost as well for all practical purposes be armed with the smooth-bore gun of a century back. A striking illustration of this is given by a writer in Blackwood's Magazine, in his description of the equipment of the Garibaldians, immediately prior

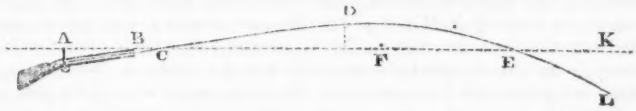
* Communicated 31 May, 1862.—Ed.

to the battle of Melazzo, in Sicily. He there states: "For the most part the force was armed with 'Enfields,' but few knew how to develope the use of that deadly weapon, the sights being deemed a superfluity." The question naturally suggests itself to the reader, Why were the sights thus deemed superfluous? and the obvious answer arises, that it was mainly, if not entirely, owing to those men, thus armed, being utterly ignorant of and deficient in the power of judging distances.

We witness now every year at Wimbledon a magnificent spectacle of rifle-shooting; but take some of those crack Wimbledon shots, and place them in an open country, in an Indian jungle, or a Chinese rice-field, and, without telling the distance, ask them to hit an object the size of a man, some considerable way off, and they will at once frankly admit their inability to do so. Judging distance is ignored at Wimbledon, and perhaps for divers reasons necessarily so; but so long as we have a rifle furnished with a back sight requiring adjustment, or retain any pretension to be practical soldiers, we cannot ignore its absolute necessity.

The question as to whether a soldier can be trained to judge distances or not, has long since been affirmatively determined, and the accumulated returns at the Hythe School of Musketry establish beyond all doubt that the majority of soldiers, provided they have average eyesight and an ordinary amount of intelligence, may acquire a proficiency in judging distance sufficient for all practical purposes.

Having thus indicated the requirement existing for every one armed with the Enfield Rifle being able to judge distance with a certain degree of approximate accuracy, I shall now endeavour to show why it is this necessity exists, and I shall also essay an explanation of the general principle upon which the present system of teaching judging distance is based.



In the above figure, let the line C D E L represent the trajectory of a bullet, and let the line A K illustrate the line of sight. If we consider the relative position of the trajectory here towards the line of sight, it will be observed that for a short distance beyond the muzzle of the supposed gun the trajectory is below the line of sight, it then cuts it at the point C, and I may remark that this point of intersection is of no value in the consideration of the firing of arms; beyond the point C, the trajectory gradually rises till it culminates at D, and here I may parenthetically remark the point of culmination in the Enfield trajectory, where it obtains its meridian height, is a very little more than mid-way at short ranges, and nearly two-thirds of the entire distance at the longer ranges.

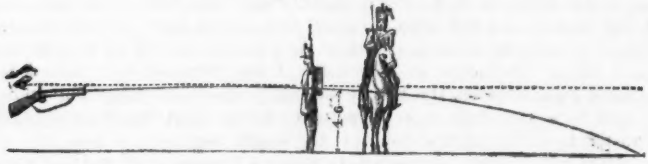
After culminating, the trajectory makes a gradual descent till it again cuts the "line of sight" at the point E, this point of second intersection of the trajectory with the line of sight is of important interest.

Abroad, this constitutes what is termed the "point blank;" the English acceptation of this term is, however, entirely different. Point blank, according to our interpretation, consists in the first graze made by a bullet fired from any piece the axis of which has been laid parallel with the horizon; as the flight of a projectile can, however, be fully explained without making use of a term so ambiguous and liable to be misconstrued, I shall dispense with further allusion to it. It will be sufficient, at present to direct your observation to the fact that to hit a small object, an apple or oyster-shell, that apple or oyster-shell must be placed in the direction of our line of sight exactly where the trajectory, which it must be borne in mind always indicates the actual course of the bullet, makes its second intersection with the line of sight; for by inspecting the foregoing figure it will be seen that if we wish to strike an object F between the point E and the muzzle of the gun and aim directly at it, the ball will pass above it a certain distance F D and it will be the same for all points between C and E: and, again, if we wish to strike an object K beyond the second point of intersection and aim directly at it, the ball would pass below it a certain quantity, H K, and so for all points beyond E. Hence it appears that, in order to hit an object, it is necessary that it should be precisely at the point of second intersection of the trajectory with the line of sight.

But fortunately for us as practical soldiers the objects we are taught to aim at and hit possess a considerable degree of height, thus the average height of an infantry soldier is assumed to be six feet, and that of a cavalry soldier on horse-back eight feet six inches, hence it follows that not only should we hit these objects when at the point E, but equally so within certain limited distances on either side of that point.

Let us give this a definite application. If the Enfield rifle is taken, and the sighting or elevation for 100 yards made use of, matters are so arranged, that if aim be correctly taken, the bullet would pass through the centre of a man's body at 100 yards distance; but as the the bullet, when fired with this elevation, never attains a greater height than 4 feet 6 inches, where in fact it culminates—and as it does not make its first graze or strike the ground till 195 yards from the firing point—it follows that not only will the bullet hit a soldier in the waist-belt when standing a hundred yards off, but it would hit him equally somewhere higher, even were he to advance to the muzzle of the piece, and on the other hand, even were he to get 195 yards off, he would there be hit in the feet.

100 Yards.



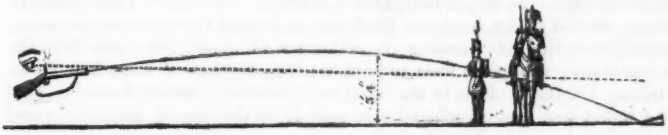
100

Thus appears that practically no one could stand in the direction

the line of sight for a distance of 195 yards with impunity, and this distance constitutes what is technically termed the "dangerous space" (for an elevation of 100 yards.)

With the elevation due for 200 yards, the bullet culminates at a height of 5 feet 4 inches from the ground, and makes its first graze at a distance ot 280 yards from the muzzle, so that we here again have Infantry under the power of our rifle throughout the entire flight of the bullet.

200 YARDS.



200 280

Moreover it is worthy of remark, that, as the bullet rebounds or ricochets at very nearly the same angle as that with which it strikes the ground, the angle of incidence and reflection being equal; and as at this and other short ranges, that angle is comparatively low and flat, so to speak, it follows that we may with a certain degree of prudence, having due regard to the nature of the ground, calculate on an effective ricochet-fire of at least some 20 or 30 yards further, so that practically it may be averred, that if the sight is adjusted to 200 yards, and the rifle be held straight, some part of a man must be hit throughout a distance of 300 yards, irrespective of any further power of judging distance than is required to tell the difference between 1 yard and 300—a useful fact this to be borne in mind by a sentry on outlying picket, if taken by surprise.

So much for the trajectory in reference to Infantry soldiers at those two ranges; small reflection is required to perceive that Cavalry would fare no better, but rather a degree worse, inasmuch as they would be equally under the influence of our bullet throughout its flight, while at the same time their greater height affords a larger target for aiming at, and the disadvantage of this greater height makes itself even more apparent to us, in reference to the trajectory, at the next and following distance of 300 yards.

With the elevation for 300 yards, the culminating height of the bullet is 7 feet, and its first graze 370 yards from the firing point, giving as a dangerous space for the Cavalry soldier on horseback, with an average height of 8 feet 6 inches, 370 yards; and, considering the nature of the ground over which Cavalry must of necessity act, and their greater height, it certainly would not be too much to assume that we may depend on the effect of ricochet fire for some 30 yards beyond the first graze; hence we arrive at the important conclusion that, admitting you are no judge of distances, all that an Infantry soldier need do if attacked by Cavalry is, to adjust his sight to 300 yards, and calmly wait till his mounted enemy come within the to him fatal distance of 400 yards, in order to make him bite the dust, for such is the lowness of our trajectory here, that you cannot miss him.

Never did knowledge more clearly constitute power than this; and had the 93rd Highlanders, or rather those who commanded them, but known this little fact on the morning of the 24th October, 1854, we might have been spared the disastrous sequel of the Light Cavalry charge.

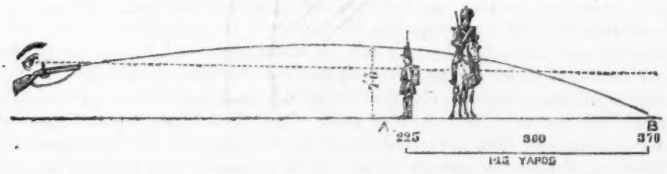
As a proof that I am not at all exaggerating the effect of ricochet fire at those distances, I may adduce the melancholy instance of the death of Captain Collins of the 26th regiment, from the ricochet of a bullet fired at the Curragh of Kildare. "A party of soldiers were firing volleys at the usual distance of 400 yards, when, as Captain Collins was crossing the range in rear of the target-butt, at a distance of some 1,100 yards from the firing party, a bullet, doubtless fired with more than the necessary elevation, passed over the butt, making its first graze at about 900 yards from the firing point; it appears then to have made a ricochet of some 200 yards, striking Captain Collins in the heart and producing instant death." That the bullet had first ricocheted was proved by the fact of blades of grass being found imbedded in the lead.

Thus far it must be very satisfactory and consolatory to such as would seek a "royal road" to judging distance, to know that we are not absolutely dependent upon every soldier knowing the exact distance of an object, for from the height of the trajectory and its comparative flatness at the ranges to which I have just referred, we are, to a certain extent, rendered independent of judging distance.

We now arrive, however, at a point where the necessity of being able to judge distance with a greater degree of accuracy becomes clearly palpable, for as our bullet attains a culminating height of 7 feet when fired with the elevation due to 300 yards, it follows that during a portion of its flight it would manifestly pass harmlessly over the head of a soldier, *even* were he a giant 6·99 feet in height.

It has been determined by careful experiment, that the bullet would first catch an Infantry soldier in the hair of the head as it were, at 225 yards from the firing point; at 300 yards, provided aim had been properly taken, it would strike a man in the waist-belt; and at 370 yards it would strike him somewhere in the feet.

300 YARDS.

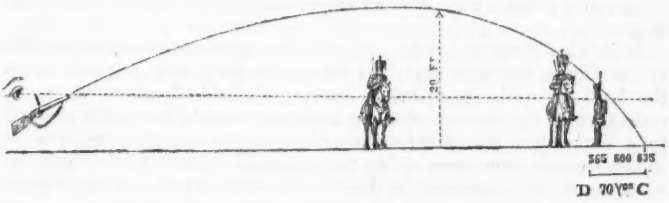


Our dangerous space, therefore, is now limited to the distance between A and B in the above figure, that is 145 yards.

With the view of showing that the necessity of judging distance increases with the range, let us proceed at once to trace the course of the trajectory at 600 yards. The bullet now reaches a height of 20 feet before culminating; it first catches an Infantry soldier in the crown of the head

at a distance of 565 yards, and strikes him in the heels (makes its first graze) at a distance of 635 yards.

600 YARDS.



Our dangerous space is thus considerably curtailed, lying merely between D and C, equivalent to a distance of 70 yards. The practical inference to be deduced from this is, that to fire with accuracy the soldier should be capable of appreciating the distance of objects so as not to commit an error greater than A B in the first instance, and D C in the second, that being the respective margin permissible in either case for misappreciating the actual distance. In the case of Cavalry, in the latter instance, the margin, owing to their greater height, would be slightly more.

In teaching how to judge distances, the recruit is instructed first to take note of the size and appearance of men, placed opposite him, at fixed, known distances; he has as it were to draw a picture in his mind's eye, of these "fixed points;" to make, so to speak, a mental photograph of them, so that afterwards when he is called on to judge of men at unknown distances, by a process of inductive comparison, by looking mentally on that picture and on this, he arrives at a correct conclusion as to the number of intervening yards. At 100 yards, the lineaments of the face can no longer be discerned; the buttons seem to form a continuous line; the number or ornament on the cap is scarcely discernible from the band, but the different parts of the body: the movements of men individually, and the form and colour of the uniform, are perfectly distinguishable. At 200 yards, the buttons, as buttons, are invisible, and the face looks like a whitish ball under the cap, but the colour of the uniform, the badges of shakos, and cartouch boxes can still be distinguished. At 325 yards, the rifle at the shoulder and the different parts of the uniform are discernible: objects at this distance are said to have an apparent size of about one third their actual size. At 400 yards, objects have an apparent size of about a quarter their actual dimensions, the direction of the march of Infantry, and the movement of their muskets can be distinguished, and so on. The recruit is, at the same time, warned that all inductions of this character require modifications, dependent on his own eyesight, the position of the sun, the state of the atmosphere, and the background. A body of Infantry marching with the sun opposed to them, send out strong and constant rays of light, in the direction in which they are marching; when the sun is behind them, no light is shown. In foggy or cloudy weather, objects having less light falling on them appear more distant than they

are, whilst in clear sunshiny days, being much more lighted up, the details are more clearly visible, the object appearing nearer than it is in reality.—A man placed before any high building, high tree, &c., will appear smaller and more distant than he would appear under other circumstances, whilst on elevated ground, with the sky only visible beyond him, he will appear larger.

In judging distance practice, so called in contra-distinction to the drill, the soldier is taught to apply the knowledge previously acquired, under the head of drill, by giving a separate individual answer as to his estimation of the distance of men placed at an unknown number of yards from him; when, providing his answer is within the margin permissible, or, in other words, somewhere within the prescribed limits of the dangerous space, as already explained, he receives a number of points, in the register kept of the practice, to denote the relative value of his answer.

The foregoing explanation will afford a general clue to the principles upon which the present system of imparting judging distance in England is based—that system is admitted, I believe, to be the best extant, and is used, with but slight modification, throughout the entire continent of Europe, and the two Confederacies of America.

Enough also, I trust, has been said, without further multiplying figures, to show the advantage derivable from every soldier being acquainted with every detail connected with the trajectory of his bullet; the figures here alluded to should be familiar in the mouth of everyone armed with the Enfield, as household words; for, though it is true that instruments have been designed for the computation of distances, in the excitement of battle the soldier would not be capable of using such, and all instruments are thus far unsatisfactory either from giving an inexact approximation, being too complicated, or requiring too much time to use them.

After all, an approximation such as the practised eye can give is most to be desired, and there are few men indeed who cannot with a little labour and care attain such proficiency in judging distance as will at least enable them to strike an object the size of a battalion in column at a distance of 900 or 1000 yards.

Fired with the elevation necessary for 900 yards, the Enfield bullet actually acquires a height of about 50 feet before culminating, and hence the curvature of the latter part of its track is so great that in a measure it may be said to approach the vertical, and herein lies the difficulty of obtaining accurate shooting with the Enfield rifle at this and other long ranges; we have, as it were, not only to fire at but into an object, the bullet has to be dropped on a man's shako in order to hit him, so that the slightest possible error in the matter of elevation or taking aim is at once fatal; a finer sight than usual will cause the bullet to fall short of the mark, while a fuller sight will cause it to fall over and beyond. Moreover, we now lose the effect of ricochet-fire owing to the high angle at which the bullet strikes the ground.

Even according to the Hythe average at this distance, only 13 out of every 100 shots fired at a target 6 feet high and 12 feet wide, ever take effect. Increasing the width of the target aids us comparatively little, the difficulty is one of elevation, not direction. It is owing to this that none but highly trained soldiers, marksmen in every sense of the word, should ever

be allowed to fire at long distances (such as 700, 800, and 900 yards) at smaller objects than a column of men or troops, whose depth would make up in some degree for any misappreciation of distance, or effect of faulty aim.

To drop a ball from an Enfield rifle on to a reconnoitring staff-officer at 900 yards, could be done, probably, by only a few men in the regiment; but if a hostile battalion should endeavour to advance from 900 yards distance to 300 yards, every man in a regiment ought to contribute his quota towards their destruction, for there would be no need of nicely timing the discharge or of minute accuracy of elevation.

It therefore becomes apparent that the advantages to be derived from a low or flat trajectory cannot be over estimated; all our difficulty in shooting is owing to the bullet moving in a curved line, and if it were possible to have a rifle to project a bullet in a line, parallel, or nearly so, to the earth's surface, I need hardly say, judging distance would be no longer necessary, and schools of musketry become to a great extent superfluous. The Enfield rifle is surpassed in this respect by rifles which have emanated from private manufacturers, and by none more so than that of Mr. Whitworth, which, so far as reliable data can be taken, has the flattest trajectory known.

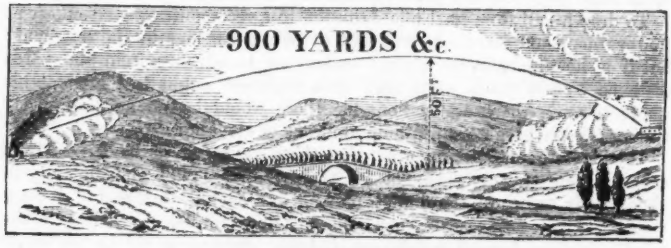
To put the comparative merits of these two weapons in the matter of trajectories in more familiar and definite terms, I may state, that, whereas the curve described by the Enfield bullet at 500 yards (fired at an angle of 1° 30′) attains a height of 15 feet at its highest part, the Whitworth at this range (at an angle of 1° 15′) only acquires a height of 8 feet 6 inches, in other words, the trajectory of the Whitworth, at this range, is more than 40 per cent. lower, and therefore better, than that of the Enfield, and the practical corollary which flows forth from this fact is, that if a body of cavalry were to charge riflemen (infantry) from a position 500 yards off, the Whitworth bullet aimed for that distance would hit them in any part of its flight, while the Enfield, at the centre of its curve, must whistle harmlessly over their heads, though a first-class marksman fired the shot.

Although the highly curved trajectory of the Enfield-rifle at long ranges must obviously be regarded as a decided fault and a weakness, so to speak, in its construction, yet certain exceptional circumstances may arise, under which this very fault may be turned to positive advantage.

In actual warfare it continually happens that troops advance to storm a breach or attack an enemy in position, covered by the fire of artillery. This was done, for example, with admirable result, at the seige of San Sebastian, in Spain, and again, in more recent times, with a like success, at the capturing of the Taku Forts the other day in China; in the former instance, howitzers were for the most part made use of; in the latter instance, Armstrong rifled field-guns, fired with a smaller charge and increased elevation. Now, let us put artillery on one side, and, assuming that it has been prevented coming "to the front," owing to the nature of the ground, want of horses, or some of the other hundred and one impedimental accidents liable to occurrence in the best regulated war, let us see, whether under such circumstances the Enfield might not, in a modified manner, be made to do the work of the big guns.

We will suppose that a small brigade of infantry consisting, say, of three regiments, with a respective effective strength of 600 men, armed with

Enfields, but unsupported by artillery, have to attack an open field-work which has been thrown up and occupied by the enemy.



The work rests on the crest of a hill, the natural slope of which serves as a glacis, girt at its base by a small stream spanned by a bridge, which, owing to the nature of the surrounding country, constitutes the only practicable approach; the attacking force advances in column across the opposite declivity (or plain) till within range of the enemy's artillery, when it deploys into line, and a further advance is made till within some 900 or 1000 yards of the enemy's work, and here, while one half of the force continues to move on to the assault, the other half commence firing volley after volley into the open area of this field-work, over the heads of their comrades, at the easy rate of two volleys per minute, thus 1,200 men would in ten minutes project no less than 24,000 Enfield bullets into the Redan, into a comparatively circumscribed area; beneath such a hailstorm of lead, it would be impossible for human life to exist, and the storming party would clamber over the parapet only to find guns deserted and gunners *hors de combat*.

Nor must it be supposed that the occurrence of an incident such as I have attempted to describe, is beyond the limits of probability or fact, on the contrary, it is authenticated that at least upon two occasions during the suppression of the Indian mutiny, a similar adaptation of the Enfield rifle was made under nearly parallel circumstances to those here related. But, even admitting that the chances of such a combination of circumstances recurring are few and far between, and leaving out of view the possibility of partially covering the advance of troops by means of Enfield rifle fire; what has been said will at least serve to show that the vertical fire of the Enfield at long ranges may be made use of with admirable effect for siege purposes, where a large area is presented for firing into, for enfilading a redoubt, or hindering a working party throwing up a field-work; nor must it be supposed that the range of the Enfield rifle for purposes of this kind is limited to 900 yards; it is capable, in reality, of being used effectively at much longer distances (the soldier, with that view, having merely to raise his eye as much above the back-sight as the distance appears to justify, still keeping the foresight aligned with the object). Instances are on record in this country of the Enfield having killed sheep 2000 yards off, and at New Zealand, during the present war, in the country of the Taranakis, one was fired with effect from a fixed rest with an elevation for 3000 yards.

After the fall of Sevastopol, amongst other things, Russian officers related that their men, when seated smoking in fancied security beneath their doorways, had frequently been struck down by Enfield bullets, at distances almost fabulous. Its deadly effect at vast distances made it the dread of the Sepoys, who termed it "the gun that kills without making any sound."

Notwithstanding, however, that so many things may be said in favour of the Enfield rifle, partiality must not be suffered to blind us to its defects.

The late Lord Herbert, when Secretary for War, claimed a "ten years' life" for the Enfield rifle; experience proves, however, that its longevity is even less than this, and practicians know full well that long ere that prescribed decade has run its course, the weapon, owing to an inherent susceptibility to the abrasion of the bullet, and the frictional action of the ramrod, especially towards the muzzle, where the grooves are shallowest and barrel weakest, ceases to be a rifle in all save name. Under such circumstances, the economy of continuing the manufacture of this description of rifle, and its retention as a service arm, may well be called in question. Any scruples of an economical kind, however, must give way to doubts of a graver character, when the *comparative* efficiency of the weapon is considered.

Without entering into detail, it may be stated that a careful investigation will satisfy any one that this particular arm, if it has not already become inferior to that of other nations, is at least greatly inferior to the rifles which have emanated from the private gun factories of this country—rifles which are made use of at every Volunteer rifle match, to the almost entire exclusion of the military arms.

In effect, the trajectory of the "Enfield" is, practically speaking, too high. At great distances the bullet plunges, and the "dangerous space" is reduced to a few yards, thus necessitating an elaborate system of judging distances.

It is true that a reduction in the height of the trajectory involves, almost as a necessity, a reduction in the bore of the rifle, and against this it is gravely argued, that the calibre of the Enfield could not be reduced without injuriously affecting its efficiency as a military arm, and that in order to kill a man the projectile must have a diameter of ·577 of an inch, and that the Whitworth bullet with a diameter of ·45 of an inch is too small for that purpose. This surely is "splitting hairs." One cannot but remember that the self-same argument was urged in days past against the introduction of the "Enfield;" and the Duke of Wellington, who was obstinately wedded to "Brown Bess," stickled to the last for its large bore, and the necessity of making a big hole in the enemy; so that, had he lived, our men would have had to fight at Inkerman with smooth-bores versus rifles.

The increased power of penetration surely more than neutralizes any hypothetical disadvantage arising from the reduction in the diameter of the projectile.

At Inkerman, an Enfield bullet was known to pass through three Russians; and, as at Hythe, in 1857 (*vide* Report), it was demonstrated that the relative penetration of the Enfield and Whitworth projectiles was as 4 to 11, it follows, as a consequence, by the simple application of the rule of three, that at Inkerman, where, as every one knows, the Russians were in close

order, one Whitworth bullet would have killed eight Russians, slightly wounding the ninth!

Another argument usually brought forward against the gradual adoption of a rifle with a smaller bore than that of the Enfield is, that it would necessitate our having two sizes of ammunition in the service; but this objection cannot surely be seriously entertained, inasmuch as the evil, if such it can be called, would be merely of a temporary character: moreover, the exception loses much of its force from the fact of our artillery having many different sizes of ammunition in use at one time.

In conclusion, I cannot but express regret, before quitting this subject, that the Volunteers, who were expected by the regular service to originate so much of a progressive character as to weapons of war, should have contented themselves with the common arm of the private soldier, instead of making a strenuous effort to obtain a small-bore breech-loader, with the trajectory so low and flat that the necessity of judging distance would have been rendered unnecessary, and the close advance of cavalry made impossible.

That in course of time the bore of the Enfield will be further reduced, and that the present system of muzzle-loading will eventually give way to that of breech-loading, is beyond a doubt, and for the sake of the British soldier let us hope that this good time coming, is not far distant.

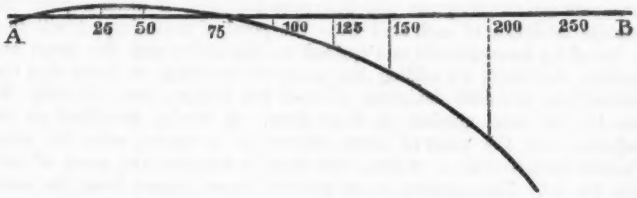
An eminent statesman recently remarked, that the spirit of progress of the nineteenth century generally ends in a recurrence to ancient ideas, progress in knowledge and civilization reproduces the contrivances of an age which we style barbarous; the great points sought for in the military rifle of our day are celerity and accuracy—that it should be *celer et certus*—be capable of a quick discharge, and up to a reasonable distance possess unerring accuracy. These are the very qualities our worthy forefathers claimed for their long bows 600 years ago; the Old English long bow had a range of 600 yards, and it could shoot 12 times in a minute: we want nothing more in a good breech-loader.

So true it is that "there is nothing new under the sun"—in this very paper, many of my ideas have been gathered from the remarks of others, who have gone before, or are yet alive; but, while making this general and grateful acknowledgment to them, I trust it will not render the substance of these remarks less acceptable at the present time.

APPENDIX.

Method of determining practically the Construction of the Trajectory of a Musket or Rifle.

Strictly speaking, in order to trace the trajectory, it would be necessary to find the mean vertical deviation of a given number of shots for all points between the muzzle of the rifle and the limit at which it is wished to trace the mean curve; for it is obvious, that if we can obtain the vertical drop as it were of the mean point of impact of a given number of shots, fired without changing the charge, direction, or elevation, at all points of our range, the curve can then easily be drawn by simply uniting such points in a continuous line. But to save the time and trouble necessary for such a labour, it is sufficient for all practical purposes if we limit ourselves to finding the mean vertical deviation of a given number of shots, fired under the conditions already specified, corresponding to the principal distances likely to be used in practice, such as 25 yards, 50 yards, 75 yards, 100 yards, 200 yards, 300 yards, &c., and then use them in the following manner:



Upon the indefinite right line A, B, representing the line of sight, take lengths proportional to the distances, 25 yards, 50 yards, &c. &c., and through each point, thus found, draw a perpendicular, upon which measure the vertical distance found for the point of mean impact corre-

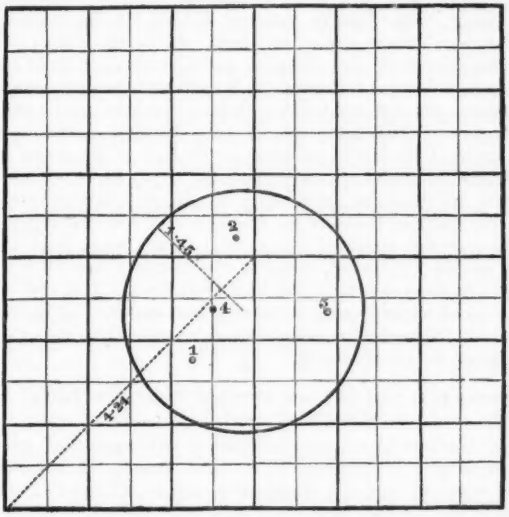
sponding to this distance. Join all the points thus found by a curve continuous and regular; this curve is the same nearly as if we had obtained all the points of mean impact and joined them, or, in other words, it is the mean trajectory of the arm. "This method, simple and expeditious, presents sometimes irregularities; when, for instance, owing to the difference of height of the points of mean impact, the curve presents inflexions that reason and common sense refuse to admit. In this case, rectify in the following manner: by taking into consideration the general form of the curve, and trace it in such manner as to leave as many points above as below, and give it a mean direction between all the points. This is done by increasing the less and diminishing the greater heights in a convenient manner. In every case, before making the rectification, seek to ascertain the causes of these irregularities, and endeavour to remedy them if possible by new experiments. Such is the method to be followed to determine, with anything like accuracy, the trajectory of an arm. It was in this manner that the French determined the trajectory of their musket, firing with a charge of 138 grains, and ball 0·62 of an inch. The precautions taken for this important operation, the skill of the marksmen that fired, the care with which they verified by calculation, and corrected by the drawing of the data obtained, all induce the belief that the utmost confidence may be given to the result of their labours, and that the trajectory thus determined was as nearly correct as it is possible for it to be."

Method for ascertaining the Mean Deviation.

A mark must be fixed upon to aim at, so that the whole of the shots may strike the target, and aim is always to be taken at the same point. A diagram must be kept on which each shot should be placed according to its position upon the target; each shot to be measured horizontally from left of target, and these horizontal measurements to be totalled and divided by number of hits, thereby obtaining the mean horizontal measurement. The mean vertical measurement is obtained by measuring vertically from the bottom of target; the total divided by number of hits gives the mean vertical measurement; the intersection of these two measurements on the diagram will determine the point of mean impact; the absolute deviation of each shot from the point of mean impact will then be found by measurement and applied to the scale; and the mean and absolute deviation, by adding the absolute deviation of every shot (including the absolute deviation allowed for misses), and dividing the sum by the total number of shots fired. A circle, described on the diagram from the point of mean impact, as a centre, with the mean absolute deviation as a radius, will show at a glance the merit of each arm, &c. &c. The distance of the point of mean impact from the mark aimed at is calculated in the same manner as for the absolute deviation of each shot, and denotes the error due to wind and defective sighting.

The allowance for misses might be half the diagonal of the target, which is the measurement from the centre of target to any of its four corners.

DIAGRAM SHOWING THE MEAN ABSOLUTE DEVIATION OF 5 SHOTS.



6 feet square.

No. of Shots.	Measurement.		Deviation.		Absolute Deviation.	Remarks.
	H.	V.	H.	V.		
1.	2·27	1·76	·58	·64	0·87	
2.	2·76	3·20	·09	·80	0·84	
3.	„	„	„	„	4·24	Miss.
4.	2·52	2·35	·33	·05	0·31	
5.	3·87	2·30	1·02	·10	1·00	
TOTAL . . .	11·42	9·61	2·02	1·59	7·26	
MEAN . . .	2·85	2·40	„	„	1·45	

The Siege of San Sebastian, page 443.

The incident here referred to is thus chronicled by Sir William Napier the brilliant historiographer of the Peninsular War:—"Graham, standing on the nearest of the Chafre batteries, beheld this frightful destruction with a stern resolution to win at any cost; and he was a man to have put himself at the head of the last company and died sword in hand rather than sustain a second defeat. But neither his confidence nor his resources were yet exhausted. He directed a new attack on the horn-work; and, concentrating the fire of fifty heavy pieces upon the high curtain, *sent his shot over the heads of the troops gathered at the foot of the breach;* a fearful stream of missiles, which, pouring along the upper surface of the curtain, broke down the traverses, shattering all things, and strewing the rampart with the mangled limbs of the defenders. When this flight of bullets first swept over the heads of the soldiers, a cry arose from some inexperienced people 'to retire, because the batteries were firing on the stormers;' but the veterans of the light division being at that point were not to be so disturbed, and, *in the very heat and fury of the cannonade,* effected a solid lodgement in some house ruins actually within the rampart on the right of the great breach."

Report referred to in page 445, *and extracted from* "THE TIMES" *newspaper, dated* 23*rd April*, 1857 :—

"For the last few days a very interesting and important series of experiments has been in progress at the Government School of Musketry, Hythe, in order to test the comparative merits of these two rifles. The trial, which was of the most searching and impartial character, was conducted by Colonel Hay, the able head of the school, and has terminated in establishing beyond all doubt the great and decided superiority of Mr. Whitworth's invention. The Enfield rifle, which was considered so much better than any other as to justify the formation of a vast Government establishment for its special manufacture, has been completely beaten. In accuracy of fire, in penetration, and in range, its rival excels it to a degree which hardly leaves room for comparison.

"The following table gives the best results that have been obtained from ten shots of each arm respectively in the course of the experiments, which have extended over a week in time, and were brought to a close yesterday, in the presence of Lord Panmure, and of a number of military and scientific spectators :—

Rifle.	Range in Yards.	Elevation.	Figure of Merit.
		Deg.	Feet.
Whitworth	500	1·15	0·37
Enfield		1·32	2·24
Whitworth	800	2·22	1· 0
Enfield		2·45	4·11
Whitworth	1,100	3·45	2·41
Enfield		4·12	8·04
Whitworth	1,400	5·	4·62
Enfield		6·20 to 7·	No hits.
Whitworth	1,800	6·40	11·62
Enfield		—	—

"It would appear from these figures that at 500 yards, in 10 shots, the Manchester rifle has a superior accuracy of 1·87 of a foot; at 800 yards, 3·11; at 1,100 yards, 5·63; and at 1,400 yards and upwards the Enfield weapon ceases to afford any data for a comparison. In penetration, the results obtained have been equally decisive; the Whitworth projectile with the regulation charge of powder going through 33 half-inch planks of elm, and being brought up by a solid oak bulk beyond, while the Enfield ball could not get past the 13th plank.

"The shooting on Tuesday was more to satisfy Lord Panmure and the other strangers present upon the comparative merits of the two weapons than to show the limit of what each could do under favourable circumstances. Still the targets of every ten shots on either side bore decisive evidence of the superiority of the new rifle, as a glance at the following table will prove :—

Rifle.	Range.	Elevation.	Figure of Merit.
		Deg.	Feet.
Whitworth . . .	800	2·22	1·41
Enfield		2·45	5·67
Whitworth . . .	500	—	1·27
Enfield			3·30
Whitworth . . .	500	—	1·33
Enfield			4·01

"The last entry in the table records the mean radial distance from a central point of 10 shots fired from a table-rest by Colonel Hay and Mr. Guner, the manager of the Enfield factory. Both are first-rate marksmen, yet at 500 yards the Manchester rifle in the hands of the former gives three times as good shooting as the latter can get out of the Government arm. All the other trials were made by firing from a beautifully-constructed machine rest, which placed both weapons on a footing of perfect equality as to the conditions under which they were tested. In addition to the foregoing experiments, there was one for showing that with cylindro-conoidal balls, on the expansion principle of those used for the Enfield rifle, very superior shooting could be obtained from Whitworth's hexagonal bore. This was most satisfactorily established, the mean deviation on the target from the centre of the group of 10 hits being only ·85 of a foot at 500 yards range. It will be observed that at 500 yards range, at which the practice commenced, the shooting of Whitworth's rifle was so much better than the other that no great distance was attempted. A reference to the first table of experiments will also demonstrate that the target made by the former weapon at 1,100 yards is nearly as good as that made by the latter at 500. These are great results to have achieved, and amply justify the forethought of the late Lord Hardinge in securing the services of so eminent a mechanic as Mr. Whitworth for the improvement of the rifle. Until he took the subject in hand, the proper principles for guidance in the construction of the weapon had not been accurately determined. The manufacture was still conducted by rule of thumb, and in a very

hap-hazard way, on the most important points. The use of grooves and an expansive projectile made it impossible to secure the requisite amount of pitch in the rifling, and the indispensable hardness of metal in the bullet for *penetration*. Moreover, from the small amount of bearing the wear and tear both in the barrel and in the projectile were enormous, and the length of the latter could not be increased without causing it to capsize in its flight. By the polygonal bore and rapid pitch, to which the form of the bullet accurately conforms, Mr. Whitworth has rendered stripping impossible, and his rifle when fired, acting exactly like a male and female screw, the projectile must rotate with perfect steadiness and precision on its axis. He can increase its length so considerably as to secure space for converting it into a shell if necessary, and, being able to use metal of any degree of hardness, he can adapt its form and strength exactly to the work which it has to perform. Thus with a rifle 39 inches long and half-inch bore, having a twist in 20 inches or two turns in its length, he finds no difficulty in penetrating a wrought-iron plate six-tenths of an inch thick, and some idea may be formed of the extraordinary power of his arm when we mention that his projectiles in their flight rotate at the rate of 15,000 revolutions per minute. The question of driving holes in the 4-inch breast-plates of floating batteries is at once solved by the application of these principles to artillery, the construction of which this new rifle proves must be completely revolutionized. A weapon which in expert hands will make good practice at 1,400 yards, and the range of which can be very easily helped by a telescope, if necessary, gives the *coup de grace* to our present system of field batteries. At the Alma it would have silenced the Russian guns or driven them from their position, rendering the rush of the light division, with the heavy loss of life consequent thereon, unnecessary. Nor during the siege of Sebastopol would the rope mantlets of the Redan and the Malakoff have given much protection to the men working behind the embrasures," &c. &c. &c.

Five years have elapsed since this was written.

SPLINT FOR COMPOUND FRACTURES.*

By S. Stacy Skipton, M.D., Assistant Surgeon, 78th Highlanders.

I am anxious to bring to the notice of the Members of the Royal United Service Institution, by means of this paper, a design of an apparatus or splint for "compound" fractures of the limbs; *i.e.*, those fractures accompanied with a wound which exposes the fractured bone to the air, such as are caused by gunshot, or other missiles of war.

In the surgical treatment of these injuries, in themselves always serious to the safety of the limb, if not actually dangerous to life, the great object is to apply a splint to support the broken bones in their proper position, at the same time that the wound or wounds in the limb may be left exposed for the application of the requisite dressings.

In the military service, and especially with an army in the field, it cannot be expected that the officers of the medical department can have access to the same resources that are available to the surgeons of a civil hospital, who are surrounded by all the materials which a liberal management permit them to make use of, modify and cut up, if need be, in order to meet the requirements of any one particular case under their care, and so render these materials useless for future casualties unless they present precisely the same conditions as the former one. With medical officers in the Army, on the contrary, economy in the amount of supplies of surgical apparatus is a primary consideration, and especially so under those circumstances in which they are likely to be most required, with an army in the field in the presence of the enemy; and *with us*, of course taking into consideration that this "field" is in a foreign country, and, may be, at a long distance from our base of supplies.

In the hospitals at Scutari and in the Crimea, in 1854-55, when the wounded arrived from the battle-fields of the Alma, Balaklava, and Inkermann, and from the trenches before Sebastopol, it was distressing to see them lying with fractures of the limbs from gun-shot injuries, for which no apparatus could be extemporised to meet the requirements of the vast majority of these cases. The medical officers were therefore compelled to use the ordinary splints from the stores, and, unfortunately, from the site of the wound being in the course of the splint, and requiring washing and dressing every day, the poor sufferer, officer or private, was daily put to the severe pain consequent upon the splint being removed, the wound cleansed and dressed, *without any adequate support to the injured limb*, and then the splint itself, which should have rendered this needful support to the broken bones, re-applied. Only those who have themselves suffered from a broken limb, and know what is the pain of having "the bones set," can form an idea of the suffering entailed upon our wounded; and, when we consider the constant state of fever which was maintained by this frequent but unavoidable meddling with the broken bone, it is not to be wondered at that so many of these severe injuries terminated unfavourably, necessitating, at the least, the sacrifice of the limb.

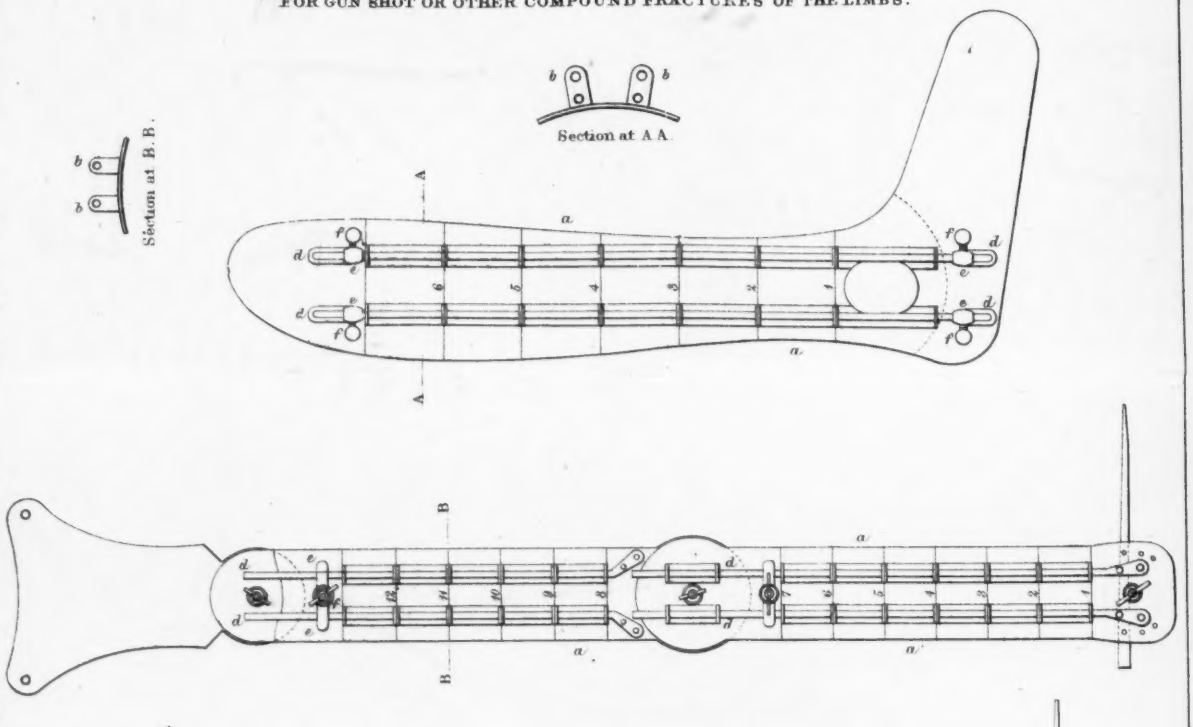
As, then, the requirements of the military service deny to a surgeon in

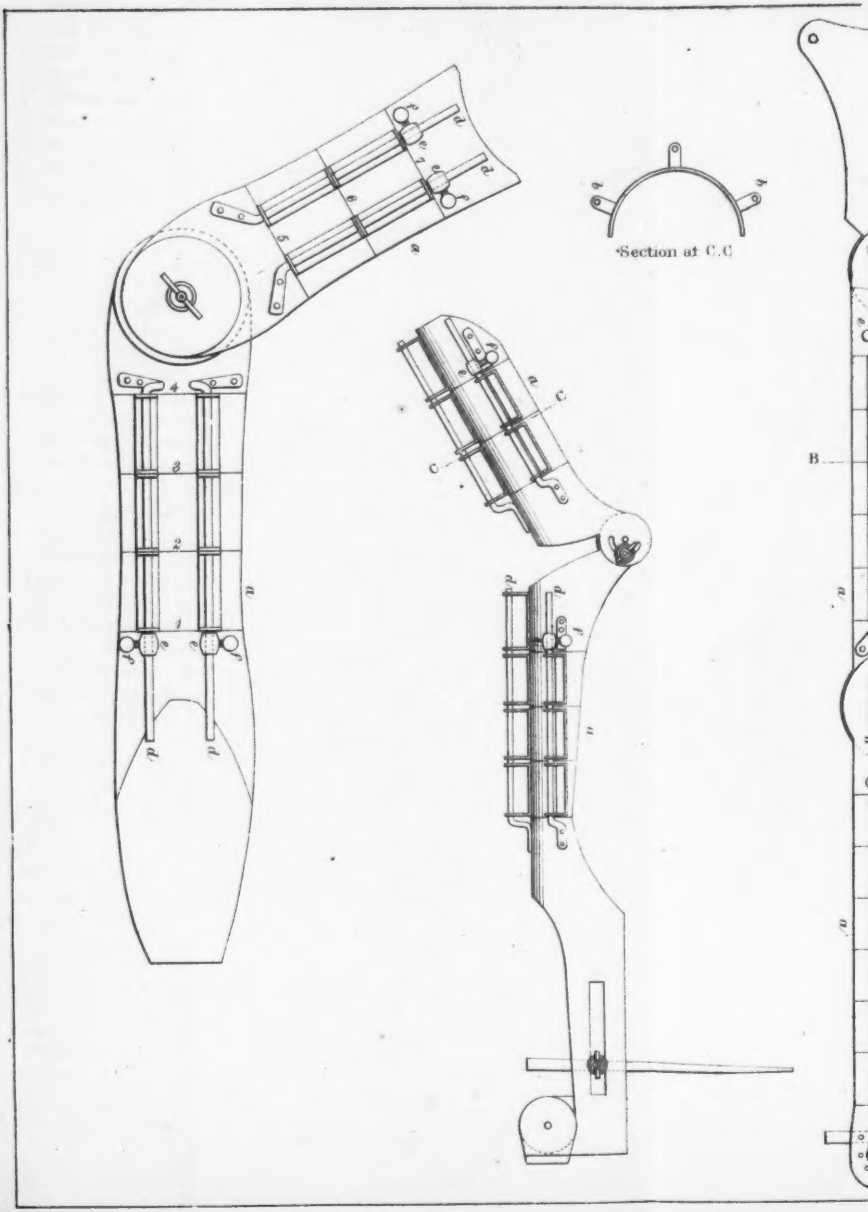
* Communicated 21st June, 1862.—Ed.

the field the great advantages possessed by a civilian surgeon, and render it necessary for the former to regard, while consistent with their complete efficiency, the portability, simplicity, and durability of his surgical apparatus, with economy also in the numbers and sizes of the splints he carries in his hospital stores, an apparatus or splint so designed as to meet all these requirements struck me as being, not only desirable, but exceedingly necessary; and such, I trust, will that be found a description of which I have now the gratification of submitting. The shape of the splints for the various limbs remains the same as those in common use, and the material best fitted for rough usage on a campaign, and which is by far the most cleanly of all, is the thin sheet-iron lacquered over, such as the ordinary splints have heretofore been made of. My object being to provide a splint, the surface of which might be capable of being interrupted at any part of its length, where, when applied to the limb, it might cover the site of a wound, I have taken any one of the common splints, cut it across into transverse strips, each of a width sufficient when removed to uncover a space the size of a gunshot wound, and at the back of these transverse strips placed vertical plates having holes pierced therein for a longitudinal bar, running along the back of the splint, to pass through; the terminal pieces of the splint are fixed to these longitudinal bars by rivets or screws at either end.

The accompanying drawings of the various splints, depicting a side-plan view of a splint for the arm and fore-arm, leg and thigh, respectively, show each to be composed of transverse strips (see Plate, *a*, *a*,) which, placed side by side, form the shape of the required splint; upon each of these are placed vertical plates *b*, *b*, (shown in a front view at the sections at A, A, B, B, C, C,) which have a hole pierced therein for a longitudinal bar, *d*,*d*, to pass through: each terminal piece of the splint is supplied with pillars *e*, *e*, and set screws *f*, *f*, or rivets to keep these pieces in their respective positions and required distances on the bars. Each transverse strip being numbered consecutively, no mistake need occur by their becoming misplaced, and thereby disarranging the shape of the splint. By loosening the screws and withdrawing the terminal piece from the bars, any one or more of the transverse pieces covering the site of a wound may be removed and set aside, and the terminal piece and the others replaced in their former position The splint thus applied, and bound on the limb with straps passing under the bars, presents an interruption in its surface, and, by leaving the wound uncovered, gives facility for cleansing and dressing it, without disturbing the support of the splint on the limb. The distance between the bars and the surface of the splint, or rather of the limb to which it is applied, renders any manipulation to the wound practicable and easy, and at the same time the patient is saved the agony and suffering, and consequent irritative fever, caused by having to remove and re-apply the splint to the broken limb after dressing the wound. Another advantage attendant upon this apparatus is, that the "pads" or cushions between the splint and the limb, and the bandages or straps which secure it to the limb, are more easily retained in a cleanly state; a desideratum to be appreciated chiefly by those who have served and suffered these injuries in a hot climate, such as that in which our campaigns have hitherto been carried on.

Dr SKIPTON'S PATENT INTERRUPTED SPLINTS
FOR GUN SHOT OR OTHER COMPOUND FRACTURES OF THE LIMBS.




Section at C.C
B

I have described the principal advantages which this apparatus possesses above the common splint heretofore in use; but there is one other yet to be mentioned, and which, with the above, it exclusively presents; and one especially to be appreciated by our medical officers, whose resources as regards the numbers of the various sizes of splints must be considerably limited, whether at home or abroad. This consists in the same splint, which, at the full length of the longitudinal bars, would be sufficiently long for a tall man, being capable of reduction in length by removing one or more of the transverse strips, and bringing down the terminal pieces along the bars, and so making the splint short enough for a drummer-boy; thus relieving another great necessity of the service, economy in the *numbers* of the splints supplied to a force, and ensuring more comfort to the patient than he would have experienced from such apparatus as we had for use at Scutari in 1854, and later, during the Indian Mutiny, where, in many instances, owing to the enormous number of wounded suddenly taken under treatment, the splints were, in addition to their great disadvantages above referred to, either too short or too long for some particular case.

While the above would appear to be sufficient to recommend its adoption in those instances in which there is a wound co-existent with the fracture, this splint may also be used in cases in which there is no wound, in which the fracture is styled "simple." In these, the transverse strips would be left on the bars, no interruption of the surface of the splint being required; and the only objection to be raised against them—viz., their slight extra weight, which the additional quantity of the material in the bars, &c., renders unavoidable—is discarded as immaterial, when we consider that the patient is lying in bed, and required to keep his limb perfectly still, especially if the fracture be "compound." If the arm or fore-arm be the limb affected, and the patient be so far convalescent as to be allowed to be up, this extra weight is then supported in a sling from the neck.

Hitherto I have only spoken of this "*Interrupted*" splint as being advantageous to military medical officers, but the same reasons that would promote its adoption in the army medical department, where it has already established itself, would also render it requisite in civil life, to surgeons in charge of the various unions, and to those in country practice, who are bound to as strict an economical use of the materials and appliances at their command as possible, and who will not fail to see that the expense of these splints once incurred, will relieve them of the annoyance and trouble attending "make-shift" appliances, and always render them capable of attending at once and satisfactorily to any case of the serious nature above referred to, which may come suddenly under their care.

As medical officers form but a small minority of the members of the Royal United Service Institution, in writing the above, I have enlarged more freely on the strictly professional branch of the subject than I would otherwise have done; but I trust I may be excused for this, and hope that the public importance of the subject may be considered as a sufficient warrant.

*** I should mention in conclusion, that the manufacturers of this apparatus are Messrs. Whicker and Blaise (late Savigny & Co.), No. 67, St. James's Street, Pall Mall, S.W., who supply the army medical department with surgical instruments.—S. S. S.